ALTERNATIVE USES FOR WASTE NEWSPAPER: AN INVESTIGATION INTO THE ECONOMIC VIABILITY OF OPTIONS FOR REPROCESSING NEWSPAPER IN TASMANIA IN 1991

by

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"My culture's hard,
but I got to keep him.
If you waste him anything now,
next year....you can't get as much, because you already waste.

When I was young I never wasted, otherwise straight away I get into trouble.
Even bone not wasted,
make soup or burn that bone.
Watch out....
That might be dreaming one too

That story change him now.
It should still be,
but young people won't listen.
Just chuck him away....
waste him,
destroy everything".

Big Bill Neidjie
One of the last remaining Australian Aborigines of the Bunitj Land, Gagadju, Northern Territory, Australia (Neidjie 1986:42).

STATEMENT

This thesis contains no material which has been accepted for the award of any other higher degree or diploma in any tertiary institution and, to the best of my knowledge and belief, this thesis contains no material previously published or written by any other person, except where due reference is made in the text of the thesis.

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Maree Bakker

ABSTRACT

The importance of, and impediments to, effective management of newspaper waste in Australia are addressed. It is appreciated that it is vital to establish facilities to recycle and reprocess newspaper as an avenue for appreciating the value of newspaper. The existence of collection industries depends on the creation of markets for the reprocessed material. Options for reprocessing waste newspaper are identified, and include the manufacture of pulp moulded products, building materials, animal bedding, animal fodder and file folders. Newspaper can also be used as a dewatering agent and as an industrial and domestic fuel source. The viability of establishing reprocessing facilities in Tasmania is considered on environmental, technical and economic grounds. On purely economic terms, it was found that the use of newspaper as a source of industrial fuel and in the production of non-adhesive bonded panel board are the most attractive means of generating a demand for waste newspaper. Avenues for governmental, community and industrial intervention to encourage further use of waste newspaper are examined.

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CHAPTER 1

THE JUSTIFICATION FOR A STUDY INTO THE MANAGEMENT OF NEWSPAPER WASTE, INDICATING THE RELEVANCE OF REPROCESSING NEWSPAPER

There has been increased concern for the environment in light of issues such as the depletion of natural resources and the pollution of land and sea. Many environmental problems can be alleviated by efficiently using our resources and effectively managing our wastes. There is an appreciation that waste management has an important role in perpetuating life on this planet.

This study intends to deal with the management of newspaper waste. The aims of this study are as follows:

* to consider options for reprocessing newspaper in Tasmania
* to propose a comprehensive list of options for reprocessing newspaper
* where possible, indicate the economic potential for the implementation of what appear to be the most promising options

Newspapers are often a large constituent of our waste, comprising approximately 7.5% of the waste in a typical landfill site (PNEB 1991a:6). Implications of reducing the consumption of newspaper, and re-using, recycling and reprocessing our newspaper include reducing the use of virgin resources, energy and water, alleviating the Greenhouse Effect and reducing the problems associated with the use of traditional forms of waste disposal, such as landfill. Optimal use of our waste materials may assist in the move towards a more sustainable society. A crucial factor in effective recycling and/or reprocessing is the establishment of a market for the 'waste' material: it is hoped that this thesis will help to encourage the establishment of industries which can use old newspapers as a raw material. Current impediments associated with recycling and reprocessing will be discussed, and ways to mitigate these problems will be suggested.

Justification for consideration of the options of reprocessing newspaper in Tasmania (rather than recycling it) are given in section 1.7, and include the prohibitive cost of transporting newspaper to mainland Australia for recycling, the necessity to deal with newspaper which may have been soiled or is otherwise unacceptable for recycling, and the possibility that there is a reduced market for Tasmanian newspaper by Australian packaging manufacturers and newspaper recyclers.

1.1 Background to the Study: Setting the Scene

There is increasing concern in Australia and world-wide that the earth's natural resources are diminishing, and that the quality of our environment is rapidly changing. There is acknowledgement that the elevated human population and the patterns of consumption are directly responsible for the dimunition of raw materials, pollution and the problems associated with the high demand for energy. There is anxiety over the fate of the resources which are seen to be required for perpetuation of human life on earth, and many are anxious about the preservation of the natural areas in which these resources are found.

> No-one can predict the future in detail. Past efforts to do so seem naive in retrospect. Nevertheless, we can foresee the probable consequences of some of our actions or failures to take action, and we owe it to those who will follow to look ahead as far as we can and over the broadest scope possible. The goal should be to avert the thoughtless foreclosure of options (Preston Cloud, Chairman, Committee on Resources and Man, 1969, cited in Porteous 1977:4).

There is a foreclosure of future options by depletion of common resources, especially when these resources are manufactured into items which are used for one purpose only, then immediately thrown away.

In our 'throw-away' society, we are generating massive amounts of waste. Councils and regional authorities disposed of approximately 12.8 million tonnes of waste in Australia in 1989, which is the equivalent of approximately 776 kg of waste per person per year. Most of this waste, approximately 12.3 million tonnes, was disposed of by landfill (Industry Commission 1990a:1).

Environmental and social problems resulting from traditional forms of waste disposal such as landfill include the production of toxic leachate, heavy metal contamination, litter, the generation of methane gas, odour, noise, traffic congestion, disease transmission by pests and competition for landfill space. There is often community opposition to disposing of waste by landfill and incineration, manifested by the NIMBY (Not In My Backyard) Syndrome. Environmental control requirements have been strengthened significantly over recent years with respect to the siting of landfill areas, possibly reducing options for the siting of new landfill operations, as well as increasing the costs involved with establishment and maintenance of these operations. Disposal methods such as incineration are expensive and may cause environmental problems such as the production of ash residues and the emission of harmful substances.

Along with the environmental and social costs involved with waste disposal, there are great monetary costs involved. Municipalities alone outlaid about $469 million for the collection and disposal of waste in Australia in 1989 (Industry Commission 1990a:27). On average, this amounted to an annual nationwide average of about $28 per person. Cost of waste disposal seems to be most acute in city areas, where there are fewer areas available for landfill within the city limits, and the costs involved with transporting waste to landfill sites in outer areas are very high. Due to the severe environmental, social and monetary problems resulting from the creation and disposal of waste, it is important to reduce and manage this waste.

1.2 What is the Role of Reducing, Re-Using, Reprocessing and Recycling in Waste Management?

Managing waste is integral to the maintenance of environmental protection and quality of life, and conservation, re-use, recycling and reprocessing each have important roles in waste management.

The concepts of reducing consumption, re-using, reprocessing and recycling are not new. Throughout the ages, people have thought about using resources efficiently and using materials which other people consider to be wastes. Re-use refers to the direct use of a product for the same use as the original products was made (eg. bottles are washed and refilled). Reprocessing is the production of new forms or products from used material (eg. making old newspapers into insulation). Recycling, *per se,* is the recovery of used products for manufacturing to their original form (eg. aluminium cans are made into aluminium cans). The term "recycling" is often used to encompass the definitions of reducing consumption, re-using, reprocessing and recycling, but for the purpose of this thesis, recycling will be used in its literal sense. Justification for re-use, reprocessing and recycling will be provided as an incentive to encourage activity in these areas.

In order to devise guidelines on an approach to the management of our waste, the following steps should be taken:

(1) avoid the creation of waste;
(2) re-use materials;
(3) if re-use is not possible, recover for recycling or reprocessing - provided there is an end-use and a demand for the product;
(4) if materials recovery is not practicable use it as a fuel source; and
(5) if all other alternatives are exhausted, choose the method of disposal which causes the least environmental problems.
(adapted from WARMER 1990a).

It is important to recognise that recycling is not the panacea to solve the world's environmental problems: other methods of waste management such as conservation and re-use are vital as primary options in waste management. It would seem that much of the focus of waste managment in the past has been toward the use of landfill as the chief waste mangement option. It is timely that other options for waste management are pursued, and that these options are considered before landfilling becomes the inevitable course of action. Otherwise, the problems associated with traditional forms of waste disposal will be manifested in even more acute ways.

There have been comparatively few attempts by municipalities, government and industry to effectively manage waste in Australia in the past, promoting conservation and re-use, or recycling and reprocessing as management tools. For example, of the $469 million spent by Councils on waste disposal in 1989 in Australia, only about $5 million, or 1 percent of total waste disposal costs were outlaid for the collection and sorting of recyclable materials (Industry Commission 1990a:27). Only 379,000 tonnes of the 8.6 million tonnes of waste managed by Councils was recycled in 1989 in Australia (Industry Commission 1990a:1,7). With co-operation from the public and more intensive governmental and industrial assistance for the establishment of collection and reprocessing and recycling industries, there exists the potential to increase the amount of reprocessing and recycling in Australia. The environmental, social and monetary benefits from effective waste management may be extensive.

1.3 The Importance of Managing Newspaper Waste: Justification for the Study

Reducing, re-using, reprocessing and recycling newspaper is a way of removing further pressure from the sources of the raw material (the forests), reducing the requirement for energy and water, reducing the Greenhouse Effect and reducing the demand for and the problems associated with landfill and incineration.

> If environmentalism has taught us anything it is surely that as members of a global community we can not afford to squander any resource, even if it is renewable and biodegradeable. (Softwood may be renewable, but the energy that goes into the manufacture, exploitation and disposal of paper is not.) We can no longer allow ourselves to use paper

> as wastefully as we have been doing, not without bringing the planet that much closer to being wasted itself - wasted being the American slang for murdered (Harrison 1989:11).

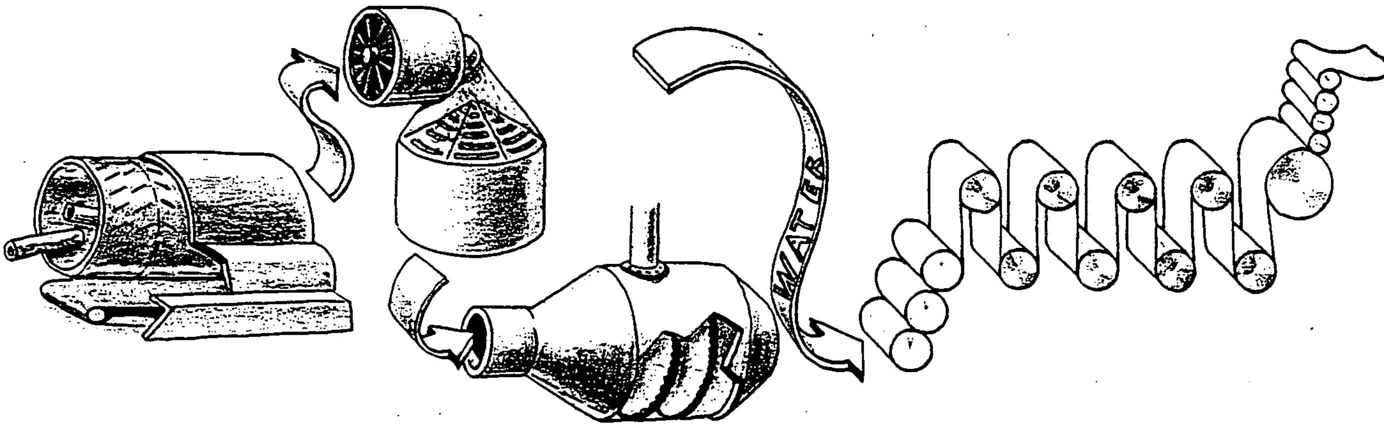
In order to justify the requirement for managing our newspaper waste, it is relevant to ellucidate the way in which newspaper is produced, and the amount of virgin materials, water and energy invested in this commodity.

Traditionally, paper was made from cellulose fibres derived from natural materials such as grass, bamboo, flax, straw, jute and papyrus. Essentially, fibre is made into a pulp, dispersed in water, rolled or spread into a thin sheet and dried (PNEB 1992) (see Figure 1). With the development of the printing press and an increase in literacy, wood was used to meet the increased demand for cellulose fibres. Modern pulp and paper technology uses wood as a resource.

In order to make paper from wood, the cellulose fibres need to be separated to produce a pulp. This can be done by either mechanical or chemical means, or by a combination of both. Chemical pulping removes much of the lignin and other residues by the use of strong acids or alkalis, producing a comparatively strong paper satisfactory for printing paper and tissue (Kroesa 1990:4). Heat and/or pressure may also be used in the chemical pulping process, depending on whether kraft, soda, anthraquinone or sulphite pulp is being produced (Industry Commission 1990b: 109).

Newspaper is produced by mechanical pulping, whereby debarked logs are stone ground, pressure ground or pulped using rotating metal discs called refiners, which causes a breakdown of the cellulose fibres (Kroesa 1990:4). Lignin can be softened by heating prior to mechanical processing: this technique is known as Thermo-Mechanical Pulping. Chemi-Mechanical Pulping incorporates the use of chemicals to soften the woodchips before pulping mechanically, and Chemi-Thermo-Mechanical Pulping is a process whereby chemically treated woodchips are mechanically pulped at high temperatures.

Figure 1: The newspaper production process, involving the debarking of logs, grinding of logs using a mechanical process, and the addition of water to form a pulp. This pulp is rolled or spread into a thin sheet and dried.



These processes leave a pulp which has a weak fibre network and little tear strength, which much lignin present. This paper is suitable for newspapers, as strength is not so important for paper which is used for one day and discarded, and the yellowing due to the presence of lignin is not an issue in paper which is used and discarded so quickly.

The amount of energy required from outside sources for the manufacture of newspaper is high compared to paper produced from chemical processing, since much of the energy used for chemical processing is derived from burning the waste materials from the process. Mechanical pulping, however, has a much higher yield of usable pulp compared to chemical processing: the former converts 95% of the wood resource into pulp, whereas chemical pulping converts only 45-50% of the wood into pulp (Kroesa 1990:6).

In Australia, newsprint mills are located at Boyer in Tasmania and in Albury, New South Wales. At Boyer there is an integrated mill, using groundwood pulp and Thermo-Mechanical Pulp, and components of purchased cold soda pulp (semi-chemical) and kraft to produce newspaper. At Albury, Thermo-Mechanical Pulping is used to produce newspaper.

The following points can be used to indicate the importance of effectively managing our newspaper waste in terms of the natural and social environment. The role of reprocessing in the larger scheme of things can be shown in section 1.7: at this stage of the discussion it is not valid to distinguish between reprocessing and other methods of waste management. For further reference, it may be useful to emphasise the importance of waste management of newspaper, not only the importance of reprocessing.

1.3.1 Managing Newspaper Waste Can Save Forests

The desire for effective waste minimisation and management of newsprint waste is often based on the grounds that it will play a role in saving forests. There has been growing support for conservation of forests and wilderness areas, and much of the concern over the fate of our forests has been directed toward the pulp and paper industry.

Managing newspaper waste in Australia will have a role in reducing the demand for the 266,000 tonnes of newsprint which is currently imported from New Zealand, Canada and Finland, hence it may help to preserve overseas forests. In 1990, 266 000 tonnes of newsprint was imported into Australia (PNEB 1991a:4).

A high proportion, 90%, of the pulp used to manufacture newspaper in Australia now comes from radiata pine plantations (News Limited 1991:9). ANM (Australian Newsprint Mills) is Australia's only newsprint manufacturer, and produced approximately 374,000 tonnes of newsprint in 1990 (PNEB 1991a:4). Pine plantations, with a rotation period shorter than that of eucalypts and a much higher yield, do have an important place in paper manufacture. "However, pine plantations are not 'forests' at all in an ecological sense. They are biologically impoverished compared to native forests, supporting little other flora or fauna; and this lack of variety leaves them more susceptible to disease or insect attack"(Hawes, undated, Ch. 5). Some may suggest that pine plantations are visually scarring to our landscape, and unsuited to the soils of Australia. Managing newspaper waste may play a role in reducing the demand for pine plantations.

It has been suggested that managing newspaper waste is not by itself a major means of preserving Australia's native forests (Wright 1991:46, Industry Commission 1990b:4). Forest authorities and paper manufacturers claim that newspaper manufacture has little impact on native forests by indicating that there is only a small proportion of newspaper which is produced from native forest pulp, that logging of old growth forests will cease, and that newspaper manufacture relies upon waste products from the forests such as thinnings from pine plantations, by-products of sawlog production or sawmill residues (PNEB 1991a:4, Tasmanian Forestry Commission 1979:35, Industry Commission, 1990b:4, Industry Commission 1990b:63, The Australian, Tuesday December 3 1991:9).

There is a degree of truth in these statements. There is a comparatively small amount of native pulpwood required for newspaper manufacture: only 10% of pulp used for newspaper manufacture in Australia now comes from native forests (News Limited 1991:9). Management of newspaper waste will have little impact on Australian native <u>old growth</u> forests after 1992, as there is a commitment by ANM to phase out the use of material from these old growth eucalypt forests (R. Fagg, National Recycling Manager, ANM, pers. comm., PNEB 1991a:13). This decision should be lauded.

Where newspaper manufacture merely relies upon waste products from the forests such as thinnings from pine plantations, by-products of sawlog production or sawmill residues, it may appear that newspaper manufacture has little impact on the forests.

Where pulpwood supplies <u>do not</u> come from by-products of sawmill production or sawmill residues, but from native forests which have been cut specifically for pulpwood, the impact of newspaper manufacture on native forests becomes difficult to ascertain. It has been suggested that the demand for sawlogs is always high, and that pulpwood is collected after the harvesting of the sawlogs (Tony Wilkins, Environmental Secretariat, News Limited, pers. comm.). This may be true for the way in which many forests are managed, however, evidence supplied to the Industry Commission (1990b:60) by ANM, the Pulp and Paper Manufacturers Federation of Australia and Bowater indicated that pulpwood is a joint product with sawlogs, not simply a waste material from sawlog harvesting. This means that, where they are permitted to do so, sawmill operators and pulp and paper companies substitute pulplogs for sawlogs and sawlogs for pulplogs, according to the change in their relative prices. It appears, in some cases, that the demand for pulpwood rather than sawlogs is encouraging forest harvesting. The management regimes followed have led, in part, to the claim of the Industry Commission that sawlogs are underpriced and over-harvested, and that pulpwood is over-supplied (Industry Commission 1990b:60). If this is the case, managing newspaper waste could have a role in preserving some forests if newspaper is conserved or if the paper recovered for recycling is used to replace the pulp which has been attained when pulpwood drives forest harvesting.

Where forestry authorities manage the forests for both sawlogs and pulplogs (under the guise of a sawlog-based demand) this harvesting can often have severe ecological impact on the forests (Hawes, undated, Ch. 8). Even where the newspaper industry suggests that they only use thinnings or the by-products from the forestry operation, some may suggest that the fact that they collect such materials does not dissociate them from the operation which was used to harvest this pulpwood. It may be that newspaper manufacturers cannot infer that they have no impact on the health of the forests, due to the impacts of the forestry operations on which they are dependent. As such, the inference could be made that managing newspaper waste can have an impact on native forests.

So, "Pulpwood supplies ... cannot be considered in isolation from the more general issues of forest management" (Industry Commission 1990b:60). There is the suggestion that the native forests are managed on a sustainable yield basis (Industry Commission 1990b:62), but some would suggest that this is very difficult. The ecological impact of forestry practices are often severe, and questions concerning the long-term viability of forestry operations often arise (Hawes, undated, Ch. 8). Some of the environmental impacts of harvesting wood in forestry operations include leaching of nutrients into waterways, soil erosion, invasion of disease causing die-back, changes in microclimate and rainfall, destruction of non-target floral species, loss of habitat for invertebrate and vertebrate animals, inappropriate burning regimes and weed invasion. Social impacts of felling trees include the pollution of recreational waterways, the damage to roads by log trucks, the power demands of pulp mills and the aesthetic damage of felling and roading (Hawes, undated, Ch. 9).

News Limited has indicated that plantation grown hardwood will replace the proportion of native timber re-growth currently used for newspaper production (The Australian, Tuesday December 3 1991:9). There is a loss of diversity of species when plantations are established, as the latter are usually planted with one species. The establishment of monocultures may leave the forest more susceptible to insect attack and disease. Even-aged regeneration stands are replacing the mixed aged forests which are essential for maintaining the diversity of species (Hawes, undated, Ch. 8). Nevertheless, in establishing the effects of plantations in Australia, it is important to acknowledge that plantations are often considered preferable to the exploitation of the virgin forest.

The environmental benefits from managing waste newspaper and other types of paper waste will only be manifested where <u>all</u> customers of pulpwood reduce the demand for pulpwood. Otherwise, as the Forestry Commission of New South Wales suggests, pulpwood which has not been purchased by some paper manufacturer, due to waste management efforts, will simply be sold to other pulpwood customers (Industry Commission 1990b:63). The same amount of pulp will be utilised.

Conventional building materials such as hardwood and plywood can be substituted with materials manufactured from newspaper (see section 2.4.1 and 2.4.2). Reprocessing newspaper into materials which replace timber can help to avoid the use of the latter materials, therefore reducing the demands on forests. Where newspaper is re-used, for example, as a packaging material, the use of conventional paper-based forest products could be avoided.

1.3.2 Managing Newspaper Waste Can Reduce Energy Consumption

If less newspaper is consumed, it may be that less energy is required to transport daily newspapers around the country. The energy consumed in driving machinery in forestry operations and transporting virgin materials may be reduced with a decreased reliance upon forest products.

One of the advantages of recycling newspaper is that there is a lower energy requirement than in the production of newspaper from virgin woodpulp; 400 kWh of electricity per tonne is necessary to make recycled pulp, compared to 2400 kWh per tonne to make pulp from virgin materials (Industry Commission 1990b:7). Since much of the electricity currently produced in the world is from the combustion of fossil fuels, an increase in recycling, lowering energy use, may reduce the social and environmental costs involved with the production of electricity, such as acid rain and the release of carbon dioxide into the atmosphere.

The energy used in transporting newspaper to landfill may be reduced if newspaper can be recycled or reprocessed locally. This would depend on the distance the paper is required to be taken to landfill relative to the distance the paper is required to be taken to a recycling or reprocessing depot.

Of course, the energy cost of the collection of newspaper for reprocessing and recycling must be assessed. An analysis of the extent of use of fossil fuels to power collection vehicles is an essential component in considering the environmental and social worth of newspaper recycling and reprocessing. If efficient methods of collection are used to collect newspaper, the energy cost of recycling and reprocessing may be reduced compared to where there is inefficient collection services.

1.3.3. Managing Newspaper Waste Can Reduce the Use of Water

If less newspaper is consumed, or more newspaper is recycled, water use could be reduced. The production of newspaper from virgin materials requires the input of large amounts of water. The production of newsprint from virgin fibre uses about 5 cubic metres of water per tonne of pulp produced, whereas the production of one tonne of pulp from recycled newsprint requires the input of 3 cubic metres of water (Industry Commission 1990b:66).

1.3.4. Managing Newspaper Waste May Reduce Pollution

The production of newspaper from virgin pulp creates pollution. Where Chemo-Thermo Mechanical Pulping (CTMP) is used to make newspaper from softwood and hardwood, there is often discharge of the wood chemicals that are removed from the pulp. The effluent from the CTMP mills may cause particular problems because sulphur is added in the pulping process, and at present the recovery of sulphur is not economically attractive. Toxic organic sulphur compounds, along with other wood wastes and resin acids, makes CTMP effluent very toxic to fish and difficult to degrade (Kroesa 1990:9). Solid wastes from newspaper manufacture are disposed of by landfill, at sea or in inland waterways. The formation of dark, decomposing and odorous sludge in estuarine waters downstream from ANM's Boyer mill in Tasmania has been attributed to a buildup of wood fibre waste from the paper manufacturing process, although this problem has been greatly reduced in 1990 with improvements in waste water treatment at the mill (HEC Enterprises Corporation *et al.* 1991:3). There is also an input of salt into many waterways due to paper manufacture (Industry Commission 1990b:73). If newspaper consumption is reduced and virgin materials are supplemented with old newspapers, pollution resulting from the production of newspaper from virgin materials may be alleviated.

It is important to realise that newspaper recycling may produce pollution, but that this pollution could be reduced by using alternative methods of recycling. De-inking newspaper is a polluting process: problems exist in the disposal of suspended solids from de-inking in aquatic ecosystems, the disposal of de-inked sludges in landfill or by burning and the disposal of salt. There is also the possibility of the presence of dioxin levels in de-inking waste (Industry Commission 1990b:74). There are arguments to suggest that newspaper does not need to be de-inked: quality paper with a grey colour could be appropriate for many applications (Vincent 1988a:8). Although it has been suggested that "research has clearly demonstrated what the market requires" (J. Swinstead, The Mercury Newspaper, pers. comm.), it may be appropriate to conduct up-to-date market research on the consumer preference for brightness in newspaper, in light of increased environmental awareness regarding the pollution arising from 'bright white' paper.

There is the possibility that newspaper reprocessing is polluting, but care can be taken to ensure that it is minimised. The manufacture of insulation from newspaper, for example, is not a polluting process if managed correctly.

Pollution arising from vehicles used in the collection of newspaper will always be a factor to consider when reprocessing and recycling, and must be addressed.

The amount of newspaper-derived litter may decrease with decreased consumption of newspaper or an increase in the amount of newspaper collected and re-used, reprocessed or recycled.

1.3.5. <u>Managing Newspaper Waste May Reduce the Greenhouse Effect</u>

Scientific debate and public concern has recently been focussed on the suspected warming of the earth's climate. The phenomenon called the 'Greenhouse Effect' is characterised by increased amounts of carbon dioxide, methane, nitrous oxide, tropospheric ozone and halocarbons in the lower atmosphere, which have been linked with a warming of the surface of the earth. Some of the possible implications of this global warming include increases in salinity of the soil and water, bushfire danger, effects on vegetation, effects on the productivity of agriculture, sea-level rises and cyclone storm surges (Pearman 1988: v-viii). It is thought that the Greenhouse Effect has the potential to "violently disrupt virtually every natural ecosystem and many of the structures and institutions that humanity has grown to depend on" (Brown *et al.* 1989:8). It is believed that the burning of fossil fuels and the large scale clearing of forests adds additional carbon-dioxide to the atmosphere (Brown *et al.* 1989:8). A comprehensive examination of the debate over the existence of the Greenhouse Effect is not within the bounds of this thesis: it has been decided that acceptance of the Greenhouse Effect as a phenomenon will lead to a cautionary perspective on the state of the earth. If the consequences of the Greenhouse Effect are less than commonly predicted, there is no harm in having erred 'on the safe side'.

An important aspect to consider in establishing the worth of managing newspaper waste is to recognise that it can help to reduce the Greenhouse Effect. In section 1.3.1, it was recognised that newspaper production can result in the removal of forest cover, therefore, newspaper production could have an impact on the Greenhouse Effect. Trees convert carbon dioxide into oxygen, and act as a store for carbon. When timber is processed, carbon is released: this carbon reacts with oxygen to form carbon dioxide. Even though trees are planted in forestry operations, initially releasing oxygen and consuming carbon dioxide at a faster rate than older trees, they are eventually cut down for paper manufacture, and the residue is often burnt, which also consumes oxygen and generates carbon dioxide. Research is currently being undertaken which indicates that forestry practices, such as fuel reduction burning and frequent harvesting, have a greater impact on the Greenhouse Effect than the retention of forests (A. Graham, Tasmanian Conservation Trust, pers. comm.).

Arguments have been presented which indicate that it is totally acceptable, as far as the Greenhouse Effect is concerned, to produce any product from wood, as carbon is still being stored in the end product. The problem with this argument is that much material is wasted to produce the end product. Of the 7 million tonnes of pulpwood collected in Australia per year, only 6.2 million tonnes is used as pulp, and, in turn, only 1.4 million tonnes of this pulp is made into paper (A. Graham, Tasmanian Conservation Trust, pers. comm.). Obviously, little carbon is stored in paper compared to the amount stored in trees.

As the electricity requirements for the production of recycled newspaper are low compared to that of newspaper made from virgin pulp, there could be a reduction in the emissions of carbon dioxide when recycling paper, acknowledging that the generation of electricity for paper manufacture often involves the combustion of fossil fuels, hence influences the Greenhouse Effect.

Consideration must also be given to the generation of Greenhouse gases which may result from the method of disposal of newspaper. The disposal of paper waste in landfill has potential to influence the Greenhouse Effect whereby the improper decomposition of paper causes the generation of methane gas, a very powerful Greenhouse gas. "One kilogram of methane produces 21 times as much global warming effect as one kilogram of carbon dioxide" (Greene *et al.* 1990: Ch. 4:1). Managing newspaper waste should be ensured so that the production of methane from newspaper in landfill is mitigated or avoided.

Of residents surveyed in the Glenorchy area of Tasmania in 1983, 38% used home incinerators as their preferred method of disposal of paper (Clouser 1984:49). Ideally, reducing, re-using, reprocessing and recycling newspaper should be encouraged in order to deter people from incinerating waste newspaper by domestic incinerators, as this combustion generates carbon dioxide, hence adds to the Greenhouse Effect.

The carbon dioxide emissions from the use of large scale incinerators as a method of disposal may also be high. Although these incinerators are sometimes used to generate heat and electricity, hence can be used to substitute for certain amounts of fossil fuels, the environmental cost in terms of the Greenhouse Effect may be too high, preventing the justification of incineration as a method of disposal.

If reduction of newspaper consumption and recycling of newspaper is heightened, there may be the maintenance of some of the forest cover which was originally destined to be used for newspaper manufacture. This would encourage a maintenance of the storage of carbon, and a reduction in the possibility of the reaction of carbon and oxygen to produce carbon dioxide. Managing newspaper waste may also have

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If reduction of newspaper consumption and recycling of newspaper is heightened, there may be the maintenance of some of the forest cover which was originally destined to be used for newspaper manufacture. This would encourage a maintenance of the storage of carbon, and a reduction in the possibility of the reaction of carbon and oxygen to produce carbon dioxide. Managing newspaper waste may also have some input into changing the pattern of global climate change whereby electricity requirements for the manufacture of paper are reduced, burning of paper is reduced, and the generation of methane in landfill is reduced.

1.3.6 Managing Newspaper Waste Can Alleviate Waste Disposal Problems

The detrimental effects of allowing waste newspaper to accumulate in landfill are not only environmental, but social and financial. The NIMBY Syndrome highlights community opposition to landfill, and the environmental effects of using landfill as a means of disposal of newspaper include visual pollution, the generation of methane gas, leaching, noise from vehicles and traffic congestion. It is not as if the newspaper in landfill can be forgotten, either. Professor William Rathje, an archaeologist from the University of Arizona, has been able to refute the assumption of biodegradeability of paper in waste disposal sites. Professor Rathje has several hundred samples of newspapers still legible after twenty years of burial. "Landfills should not be confused with compost heaps. The conditions in a landfill are the exact opposite of those needed to encourage the biodegradation of wastes" (WARMER 1991a:4). The biodegradation rates of our well engineered landfill sites are actually too slow to have any significant impact on the degradation of newspaper (Setterholm 1991:81). So, the vast amounts of newspaper that enters landfill does not simply vanish: it adds to the bulk of material entering landfill. The space required for landfill is becoming scarce and expensive, and sometimes the quest to find areas for landfill sites competes with the quest to conserve natural areas.

Present landfill disposal costs, approaching $45 per tonne in urban areas such as Sydney, for example, emphasise the need for encouraging a reduction in the amount of newspaper waste and an expansion of newspaper recycling and reprocessing industries (Industry Commission 1990a:31).

1.4 The Extent of Newspaper Recycling and Reprocessing to Date in Australia

The many advantages of managing newspaper waste have been shown. Newspapers should be targeted for waste management activity because they are widely consumed in our society, and will continue to be widely consumed. Newspapers can be accessed fairly easily. There is a daily paper delivered to many Australian households. Newsprint is also used in telephone directories and advertising material. In 1990, there were 25 million newspapers sold each week in Australia, amounting to an annual consumption of 32kg of newspaper per person. Newspaper consumption in Australlia fluctuates from approximately 540 000 to 630 000 tonnes per annum, according to the economic climate. In 1990, 630 000 tonnes of newspaper was consumed in Australia (PNEB 1991a:4). In 1991, 540 000 tonnes of newspaper was consumed in Australia (see Table 1).

None of the 540,000 tonnes of newsprint which is consumed per annum is currently being recycled into new newsprint in Australia. The inherent wastefulness of perpetually producing <u>new</u> newsprint for daily consumption and for telephone books, and the subsequent disposal of this newspaper in landfill, should be acknowledged.

The amount of newspaper which is recovered for reprocessing and for export is expressed in terms of the "recycling rate" for newsprint in Australia, which is currently about 37% of the total newspaper consumed (News Limited Figures, see Table 1). Most of what is being collected is reprocessed into paperboard packaging. Of the 201,000 tonnes of newspaper collected in 1991, 56 per cent was made into packaging material. About 45,000 tonnes of waste newspaper collected in Australia in 1991 was exported to South East Asia, where newspaper is de-inked and recycled. Approximately 45,000 tonnes of Australian waste newspaper is reprocessed into "other" uses such as insulation, pulp mouldings, and animal bedding (News Limited Figures, see Table 1). Approximately 94,000 tonnes of the total amount of newspaper collected in 1991 was from post-consumer sources; the remainder includes publishers'waste.

Table 1: The Rate of Newspaper Reprocessing and Export as at June 1991

NEWS LIMITED RECYCLING DATABASE - WEEKLY MARKET STATUS REPORT - 21/6/91

	Australian newsprint consumption (estimated tpy)	ONP post consumer collection (tpy)	Total newsprint recycled (tpy)	Newsprint recycled (tpy) for:		
				paperboard	other	export
QUEENSLAND	90,000	4,000	18,140	6,800	7,110	4,230
NEW SOUTH WALES	184,000	42,710	80,448	51,000	9,648	19,800
VICTORIA	141,000	16,707	64,982	33,000	17,062	14,920
SOUTH AUSTRALIA	44,000	6,172	8,928	6,000	2,208	720
WESTERN AUSTRALIA	72,000	23,704	27,402	15,268	7,134	5,000
TASMANIA	9,000	800	1,385	800	198	387
NATIONALLY	540,000	94,093	201,285	112,868	43,360	45,057

- N.B. Figures are based on weekly estimates expressed as tonnes per year (tpy).
- National ONP recycling rate is approximately 37%
- Sydney is collecting about 39,577 tonnes of post consumer ONP
- Melbourne is collecting about 10,929 tonnes of post consumer ONP.
- Total newsprint recycled includes publishers' waste and ONP.
- 1.4% of consumption consists of cardboard cores, wrappers and end caps, this has not bee deducted from estimates.

Note: The 'recyling rate' refers to the rate at which newspaper is reprocessed or exported

Source: News Limited.

The proportion of newspaper paper recovered in Australia is 37% (News Limited Figures, see Table 1). This is ahead of the recovery rate of Britain (25%) and the U.S. (34%), but behind the recovery rate of the Netherlands (50%) (Lunn 1991:29). The comparatively low recycling rate may, in part, be a result of the lack of facilities to recycle newspaper in Australia. The utilisation rate (the amount of old newspaper used in the manufacture of new newspaper) in Australia is currently 0%: the utilisation rate of newspaper in Germany is 50%, and in Sweden, 27% (Industry Commission 1990b:52). The amount of newspaper paper recovered in Australia would increase with the implementation of facilities to recycle newspaper, and with increases in the facilities to reprocess newspaper.

Large amounts of newspaper are disposed of in Australia every year. With an awakening of environmental awareness, the popularity of the notion of newspaper recycling and reprocessing has increased (PNEB 1992:1). People are beginning to give recycling and reprocessing wide community support, yet there is the feeling that manufacturers are not keeping up with the demands of the public (Industry Commission 1990b:1). There are many problems with recycling and reprocessing in Australia, and many of these problems need to be addressed before recycling and reprocessing ventures can be established with success. The price of wastepaper continually fluctuates; subsequently, collection industries reliant upon constant demand for newspaper fail to survive. It is true that collection arrangements are often being discouraged and discontinued because, as there has been a growth in collections, the capacity of local users and exporters to use available supplies has been exceeded (Industry Commission 1990b:49). People often discontinue domestic collection as they are confused about the destiny of their waste paper.

1.5 Barriers to Newspaper Recycling and Reprocessing in Australia

There are various barriers to effective waste management of newspaper waste in Australia at the moment, including environmental, technical and economic obstacles. To alleviate these problems and encourage an improvement in recycling and reprocessing, it may be necessary to implement reforms in the way in which government, industry and the community deal with waste newspaper. These mechanisms will be discussed in Chapter 4.

Essentially, there is greater incentive to produce newspaper from virgin resources rather than secondary resources. The Industry Commission (1990a:8) acknowledge that the price of pulpwood in Australia is too low and this low price reduces incentives to use wastepaper in the production of newspaper.

> "The recovery of RCF (recovered cellulose fibres) from urban refuse - which can supply only mixed papers of low quality at relatively high cost - is, and will continue to be increasingly marginal the more virgin fibre the country produces "(OECD 1979:39).

In countries such as Japan and Germany, virgin fibre is expensive and energy costs are relatively high; consequently, the utilisation rates of old newspaper in these countries is high (Industry Commission 1990b). Australia, until recently, has had no compulsion to use waste paper in newspaper manufacture, as the price of virgin pulp is cheap and readily available.

Existing paper producers often have agreements with State Governments to use thinning and/or sawmill offcuts, and they are bound to these agreements. These binding commitments are often made for long periods, such as 80 years in the case of Tasmania (Industry Commission 1990b:130), and dictate that there is little room for recycling activity when some of the requirements for fibre are being supplied at low cost from virgin sources.

There is acknowledgement that the price of the electricity used by paper manufacturers is too low (Industry Commission 1990b:65). This provides little incentive for recycling, since it remains economical for the production of paper from virgin fibre, using the large amounts of electricity which are required.

Another obstacle to recycling and reprocessing in Australia is that local government has set the cost of waste management too low, whereby there are few disincentives to the use of landfill as a method of waste disposal. Recycling and reprocessing have not succeeded in many areas because it is cheaper to dispose of waste by landfill than it is to recycle or reprocess. The full environmental and social costs of collection of waste and disposal in landfill have not been addressed, according to the Industry Commission (1990a:8). There is no financial incentive for householders to reduce the amount of waste which they produce: every person within a certain municipality pays the same for waste disposal, even if the householder makes an effort to reduce output of waste.

Given that there is the urge to increase the utilisation rate of old newspaper, despite the interference of government policy on the price of virgin resources, electricity and waste management costs, there are some obstacles.

The existing technology dictates that used newspapers cannot be accepted at existing mills as a source of fibre. The technologies in use by existing mills at the moment are not suitably designed for the incorporation of wastepaper, at least without some modification. So, choices of machinery which were made in the past seem to dictate that there will be limited recycling. Nick Collins from the Research Office of ANM at Boyer, Tasmania, indicated that the addition of a component of waste newsprint into the pulp which is currently used to make newsprint may jam the machinery more frequently than the production of paper from virgin wood, and this jamming involves much time and effort to correct. Basically, due to time constraints and the effort required to address these problems, it is not economic to recycle newsprint using those machines, unless they are modified. To adapt existing machinery or to be able to afford new technologies, however, there would need to be large scale investment. For example, the installation of the newsprint de-inking facility at Albury, proposed for 1992-3 will cost $100 million.

Until recently, it has been difficult for newspaper manufacturers to justify such large investment as the capital costs involved were seen to be prohibitively high. The market for recycled newspaper was uncertain due to the perceived refusal of the customers (the advertisers) to accept recycled newspaper. It has been thought that newspaper fibres continually weaken and shorten every time it is recycled, although there is some dispute over the extent of this degradation of paper quality. It has been suggested that newspaper can only be recycled four times before there is a degradation in quality, using current technology (WARMER 1991b). Another view is expressed whereby the loss in strength of the paper occurs in the first making and recycle, subsequently the properties of the paper are constant (Nick Collins, Research Laboratory, ANM Boyer, pers. comm.).

Another obstacle associated with recycling has been the insistence on the manufacture of de-inked newspaper. The polluting processes involved with de-inking have caused controversy, particularly as environmental groups suggest that de-inking is not necessary in order to acheive a satisfactory quality of recycled paper (Vincent 1988a:8). According to Piers Petitt, from the research laboratory at ANM Boyer, Tasmania, newspaper which has not been de-inked has an ISO index of brightness of 40-45, which would be unacceptable to the advertisers. With de-inking, newspaper has an ISO index of brightness of 57. It appears that the sole producers of newsprint in Australia, ANM, are obliged to produce the brighter quality of newsprint which is demanded by the newspaper companies, whose criteria are determined by the advertisers. Despite the insistence on de-inked paper rather than recycled paper without de-inking, there appears to be no way that the advertisers will be forced to bear the environmental and economic costs of the de-inking which ANM must perform, as there is no way in which ANM could build the price of their developments into the price of the paper. According to Russell Fagg, National Recycling Manager for ANM, advertisers are unwilling to accept paper which has not been de-inked. If ANM produce paper which has not been de-inked, the advertisers would purchase their paper from overseas sources (R. Fagg, pers. comm.). Since de-inking is considered compulsory, the costs must be met by the manufacturer, and these costs can be prohibitively high.

The controversial and sensitive nature of the pollution problems associated with de-inking are one reason for the delay in the establishment of ANM's de-inking plant at Albury, New South Wales.

In fact, it is surprising that the de-inking plant is actually going ahead in light of a report funded by the Australian Environment Council in 1987, which suggested that "De-inking cannot be done at Albury as residual oils and detergents, which cannot be removed, are proscribed by regulation"(McLennan *et al.* 1987:iv). The salt discharged into the Murray River from the proposed brightening and recycling plant, combined with the de-inking plant at Albury would approximate 1800 tonnes per year (Russell Fagg, National Recycling Manager, ANM, pers. comm.). Salinity in the Murray River already poses considerable problems. Although recycling could be considered environmentally sensitive by virtue of the way it takes advantage of the resources embodied in the paper and averts waste by landfill, pollution can be the result.

Even when the de-inking plant has been established at Albury, it may be that a lot of the newspaper consumed in Australia cannot be collected for recycling at this plant. It is often economically and environmentally difficult to justify collecting newspaper, especially if there is a sparsely distributed population. Transporting newspaper over long distances is particularly expensive due to fuel costs and running costs of vehicles. The depletion of fossil fuel resources such as oil, pollution from vehicles and the production of Greenhouse gases are also important to consider.

A major component of the cost involved with recycling or reprocessing is the cost of collection of the recyclable material. Agencies will only collect and sort newspapers for recycling if the costs involved can be recovered. If newspapers can be obtained from the collector for a lower price than the paper manufacturer will pay for the virgin pulp, then recycling may be undertaken. Often, however, collection and sorting costs are prohibitively large. Paper is preferentially collected from major users of paper such as the packaging and newspaper industry because it is costly to undertake the necessary separation, cleaning and grading which is required to prepare post-consumer paper for recycling (OECD 1979:38). Household collection of newspapers is comparatively costly. There is little infrastructure, such as kerbside collection schemes, to currently support effective newspaper collection.

Even if there were effective kerbside collection schemes, there needs to be a high level of community participation in collection schemes. Consumers must be taught to contribute their waste to collection schemes in order for such schemes to be successful. People must also sort their waste appropriately. There was much foreign material placed in bags in a kerbside collection scheme organised in Hobart in 1990-91, which meant that more time and money was required to be spent on sorting the materials after the bags were collected (M. Cretney, TRALAC, pers. comm.).

As a result of the limited investment in recycling and reprocessing technologies in Australia to date, Australia currently has a dependency on the international market to take some of its waste newsprint. Therefore, when there are reductions in demand in the international market, the amount of collection for recycling in Australia is reduced, and the success of collection industries is threatened. In 1988 it cost $50-70 per tonne to collect waste newsprint in Sydney, at this time the Asian market was willing to pay as high as $190 per tonne due to a drop in the supply of waste papers from the United States. The economic justification for collection was obvious (Young 1991:5). Where the Asian market was flooded due to their preference to take newsprint from the U.S., Australia's export to Asia of old newspapers was poor. The U.S. was subsidising the export of newspaper to Asia by $20 per tonne, so it was unlikely that Asia was to take Australia's newspaper. Even though new de-inking facilities are coming onto line in Asia, and this subsidisation has recently halted, the likelihood of continued competition from the U.S. due to mandatory recycling poses problems for the export of Australian newspapers, at least in the short term. With the establishment of at least 17 new de-inking mills in the U.S. and Canada by late 1992, the U.S. may have the capacity to absorb more of their own newspaper, but American newspaper will not be totally removed from the international market. Consequently, fluctuations in demand for Australian newspaper may remain in the future. Exports of old newspapers to countries other than Canada are expected to increase from about one million U.S. tonnes in 1988 to 1.6 million U.S. tonnes by 1995 (Dellinger *et al.*,1990:105).

There are times of 'boom and bust' for collection industries who meet domestic demand for newspaper in Australia. In 1988, when old newspapers were being sold to packaging manufacturers for $100 per tonne in Sydney, the collection costs of that time ($50-70 per tonne) were being adequately met. Newspapers were collected by householders due to environmental concerns, but supplies of newspapers soon outstripped the quantity demanded by the packaging manufacturers, and there was a glut of newspapers on the market. By 1990, newspapers fetched prices as low as $10 per tonne, as there was such a stockpile of paper. The cost of collection of newspapers and other lower grade papers was difficult to justify when the demand for this paper was so small and the price to be fetched from the sale of this paper fell so low (Industry Commission 1990b:49). People became disillusioned about collecting newspaper, and even when the situation improved in 1991, consumers were still of the belief that newspapers were not being collected any more, and they were not holding their newspapers and contributing to collection schemes. This phenomenon was damaging to the stability of the collection industries.

One way to reduce the fluctuations in demand for newspaper, and the subsequent collapse of collection industries, is to create consistent demand for newspaper by implementing local reprocessing industries. The manufacture of products by recycling or reprocessing is to no avail unless the goods are produced economically and there is a market for the items which have been produced. Generally, recycled and reprocessed products, in order to survive in the marketplace, must be able to compete with traditional products. Recycling and reprocessing ventures will only be successful where the demand for the product is strong enough to cover the collection costs of newspaper and the manufacturing costs of the item. The demand for the product is dependent upon the conditions of the marketplace; the receptivity of the consumer and the way in which the product has been marketed. According to Narby (1989:108), "The main constraint for recycling has been, and still is, non-acceptance of the product by the market". Consumers are often unaccustomed to recycled or reprocessed products, preferring conventional products, especially when recycled or reprocessed products are more expensive than the traditional item. Marketing aimed to encourage the sale of both newly developed and traditional recycled or reprocessed products is often necessary. There has been little market development of recycled or reprocessed products in Australia. If strong markets can be developed for products made from waste newspaper, the volatility of the commodity market can be reduced. This, in turn, may lead to the stability of the collection and reprocessing and recycling industries.

Economic, technical, social and environmental constraints, as well as governmental policy options, have impeded efforts to recycle and reprocess newspaper in Australia. Newspaper will be recycled and reprocessed if householders contribute papers for collection, if the technological obstacles can be overcome in production of new products and there are markets for the products, granted that the collection costs for newspapers are not prohibitively high. Government, industry and community can intervene to encourage these activities. Vincent (1988a:4) suggests that "Government has an important role because the market does not take into account the social and environmental costs of wasting secondary resources and the use of finite primary resources". Precedents for intervention in recycling and reprocessing by increasing the price of virgin resources, encouraging community participation in collection, increasing waste disposal charges, legislation, research and development, market intervention, tax incentives have the potential to increase the amount of reprocessing and recycling. Many of these options have been exercised overseas, and the potential for these activities to increase the amount of recycling or reprocessing are discussed in Chapter 4.

1.6 Recent Developments in Newsprint Recycling and Reprocessing in Australia

ANM has proposed a wastepaper recycling and de-inking plant, which will become operational in Albury, New South Wales, in 1992-1993. Plans are to incorporate recycling with the expansion of the mill's existing paper-making machine, introducing the capacity to include pulp from old newspapers. It has been suggested that this plant will take up all the readily available old newspapers in Sydney, Melbourne, Brisbane and Adelaide, lifting the recycling rate of newsprint in Australia. This $100 million plant will process 90,000 tonnes of old newspapers and 40,000 tonnes of old magazines per year (PNEB 1991a:8).

A recycling project in Western Australia has been proposed by Westpaper, a joint venture of Perth based Pulp and Paper International and CITIC, the Australian arm of the China International Trust and Investment Corporation. The $30 million plant will de-ink more than 40 000 tonnes of newspaper, sending 33 000 tonnes of de-inked pulp per year to South-East Asian markets. This plant is expected to come into line at the end of 1992.

The Victorian Government has proposed legislation which will require mandatory collection schemes and laws which will force publishers to buy de-inked newspaper. This type of action, it suggests, will force de-inking and recycling facilities to be established quickly to meet the demands of the Government. Accordingly, Pratt Industries announced in May 1991 that there will be a de-inking plant for packaging paper to be established in the near future in Victoria. The Victorian Government hopes that there will be 100% recycled newsprint made in that State by 1994 (Young 1991:5).

The Federal Government has proposed a National Kerbside Recycling and Resource Recovery Scheme, whereby a target of 40% recovery of newspaper has been set. A major aim of the recovery scheme is to provide stable markets for newspaper (M. Cretney, TRALAC, pers. comm.).

Newspaper manufacturers are opposed to legislation and compulsory targets for newspaper recycling, preferring to suggest that the industry can regulate itself (Young 1991:5). In response to the National Kerbside Recycling Plan, ANM and Tasman Pulp and Paper Limited, in conjunction with Australian newspaper publishers, expect to be recycling a minimum of 200,000 tonnes of newsprint by 1994, elevating the recycling rate to 45% (Frith 1991:19). A minimum of 65,000 tonnes of newsprint will be reclaimed from printer's waste and returns, and 135,000 tonnes will be collected by kerbside collection of newspaper and telephone directories. This kerbside collection will be organised by ANM and Tasman Pulp and Paper.

In response to public demands for paper recycling, the major newspaper publishers have established the Publishers National Environment Bureau (PNEB), which is compiling data and developing strategies to reduce waste in the newspaper industry. The PNEB administers a $4 million fund which has been distributed through State and Commonwealth Governments, and so far this fund has been used to assist existing recycling and collection industries, for provision of export subsidies and for research and development into re-using, reprocessing, recycling and safely disposing of newspapers. Projects sponsored by the PNEB include support for five projects at the University of Wollongong which combine newsprint with other waste products for building, fuel and mining applications. Also in New South Wales, there is a project which is being undertaken to produce a Treestart Disc for fertilising and mulching trees. In Tasmania, the Cygnet Recyclers Co-operative Society has been funded to manufacture mulch mats from waste newsprint. In Western Australia, Good Samaritan Industries have been funded to meet design costs to produce newsprint logs for domestic heating. A company in Sydney has received $33,000 from the PNEB to assist in the establishment of a facility to manufacture coffins from newspaper (PNEB 1991b, PNEB 1991c).

1.7 What is the Importance of Reprocessing Newspaper?

The importance of managing waste newspaper has been stressed in previous sections. It is relevant to discuss the role of newspaper recycling as a waste managment tool, in order to paint the larger picture of the destiny of much of our newspaper, but it is also important to recognise that recycling is not always the most appropriate form of managing waste paper. It may be that the amount of recycling is limited by the distance of recycling facilities from the major sources of newspapers, the cities. The environmental, social and economic costs of transporting newspaper must be acknowledged. There is also pollution associated with de-inking facilities, which must be considered. It is expensive to install recycling facilities. Recycling cannot be used to manage all waste newspaper.

For the de-inking and recycling operations proposed for Albury, Perth and Melbourne, it is likely that the preference for newspaper will lie with that which can be taken from the capital cities of the eastern states of Australia (PNEB 1991a:8). Although it is possible that the de-inking plants may project the demand for newspapers in non-metropolitan areas to a higher level, it is difficult to tell how much newspaper will be demanded.

The costs incurred by transporting waste newspaper may deter ANM from accepting waste newspaper from the more remote areas, such as Tasmania. If collection agencies must collect and deliver newspapers to Albury from areas other than the major cities, freight costs may be prohibitively high. It may be possible that ANM organises their own freight, and can collect from 'remote' areas with no major losses in their own profit, but it is unlikely that this paper will consistently be in demand. The option to implement reprocessing facilities in these remote areas may assist in dealing with this newspaper waste locally: reducing the reliance upon contributing to de-inking facilities. Transport costs involved with contributing to local reprocessing schemes will be comparatively small.

It would also be ideal to reduce Australia's dependence on foreign countries to absorb varying quantities of our newspaper. One way to do this is to implement reprocessing schemes. It was shown in section 1.5 that the fluctuations in export demand have a damaging effect on collection industries.

The PNEB also acknowledges that there is the need to look at old newspapers which are not uniform in quality. De-inking and recycling plants will only accept good quality newspaper for manufacture into new paper. Paper which has been soiled may be unacceptable for recycling, but may be used for other purposes, such as providing energy and composting (PNEB 1991a:9). In time to come, newspaper which has been recycled many times may not meet the standards of the recycler, so other uses for this resource must be found to reduce the waste which may result from <u>not</u> finding a use for this newspaper.

According to the Industry Commission (1990b:1) there is consensus that Australia is close to the economic limit for packaging papers. If the supply of newspaper which is used in cardboard production is being met, and the demand for newspaper by recycling plants in Albury, Perth and Melbourne is also being met, this may suggest that opportunity lies in the development and manufacture of new ways of dealing with newspaper, rather than wasting it or relying on exporting it.

Reprocessing is an effective way of using waste newspaper. There needs to be an encouragement of the use of old newspapers in new applications such as those being developed in the building, packaging, horticultural, agricultural, insulation and paper moulding industries. Research and development into other new reprocessing technologies also has an important role. Marketing should be used to encourage the sale of new products made from newspaper. With marketing tools to allow recycled products to compete with traditional products or to create successful market niches for new products, the use of old newspaper may increase. If newspaper use was to increase by the development of reprocessing industries, there would be stability in the collection industry and the problems associated with wasting this precious resource will be alleviated.

The following chapter is designed to present many of the options for reprocessing newspaper, and is based on information gleaned from interstate and overseas sources. An investigation into the economic viability of implementing many of these options in Tasmania is given in Chapter 3.

CHAPTER 2

AN INVESTIGATION INTO ALTERNATIVE USES FOR WASTE NEWSPAPER

In Chapter 1, it was possible to establish the important role of reprocessing newspaper waste. In order to fully appreciate the resources that were invested in the manufacture of newspaper, and the necessity to reduce the waste entering landfill, opportunities to reprocess newspaper are required to be developed. Research into the many ways of reprocessing newspaper has been undertaken and described in this chapter. Of course, for reprocessing to be truly successful, reprocessed items must enter the marketplace. The importance of marketing these items and the economic issues involved with reprocessing these items will, in turn, be discussed in Chapter 3.

Research into potential mechanisms for reprocessing newspaper was undertaken by various methods. Personal communication was established with members of:

* the waste management industry
* existing recycling and reprocessing industries
* newspaper publishers and manufacturers
* Tasmanian State and Local government
* conservation groups, and
* the community.

Contact was made within Tasmania, on mainland Australia and overseas. Reference was made to waste management journals, newspapers, books and pamphlets. On-line computer satellite searches were undertaken at the University of Tasmania library. The National

Technical Information Service was also consulted. Information was gleaned from television and radio, and from conversations with fellow students and staff, some of whom offered to take part in a "brainstorming" session. Brainstorming is a technique referred to by Waddington (1977:200) which is used to rapidly generate a large number of ideas from a small group of people. The author also visited reprocessing industries, research institutions and community groups in New South Wales. Limited laboratory work was undertaken to assess the capacity of hammermilled newspaper to adsorb spilt oil.

From these sources, it was possible to develop many ideas for the reprocessing of waste newsprint. Ideas which have already been developed are given relatively little attention in this thesis: it is considered that new innovations in reprocessing technologies need more attention. In making recommendations regarding the use of newspaper for domestic, artistic, building, packaging and agricultural and horticultural purposes, it was vital that the toxicity of newspaper inks be ascertained. A review of the toxicity of newspaper inks is provided in Appendix 1. Health concerns have forced newspaper publishers to move to more occupationally and environmentally benign inks. Newspaper inks are essentially made of carbon black and bitumen. Heavy metals have been removed from newspaper inks, and there is a move towards the use of vegetable-based inks. Despite the assurances, to allay any possible fears for health, it is recommended that if newspaper is to be used for agricultural or horticultural purposes, paper printed with vegetable-based inks is to be used.

2.1 Paperboard, Pulp Moulded Products and Papier Mache Products

The most common way of reprocessing newspaper is to use it in the manufacture of cardboard for packaging. It is also possible to mould shredded newspaper into any shape or form with the addition of water, heat and pressure. Subsequently, these products can have varied uses. Techniques such as papier mache also enables old newspaper to be put to many artistic and practical uses.

2.1.1 Paperboard and Cardboard

Newspaper can be repulped, reformed and dried, printed, cut, folded and glued to yield paperboard cartons, such as cereal packets, or cardboard boxes. Uses for paperboard and cardboard also include wine separators, battery separators, combustible cartridge cases, and fibre drums.

Cardboard and other packaging products can be designed for load-bearing. They are often used to carry material which is heavy, isolating the contents from the external environment. "The ability to make these products inexpensively for shipping or transmitting such diverse materials as powdered chemicals, eggs, and refrigerators is a challenge for papermakers and converters" (Schniewind 1989:213)

2.1.2 Paper Moulded Products

The most characteristic item produced by pulp moulding is the egg carton. By changing moulding dies, it is possible to make any sort of product such as fruit trays, wine racks or decomposing plant pots.

An example of a machine which has been used to mould paper or board is the pulp moulding machine range produced by Tomlinson Emery International Limited. Pulp moulding machines of this kind are used in over 50 countries worldwide to produce food, drink and other packaging products from newspaper and cardboard. The pulp moulding machines can produce items which replace those made from petroleum based plastics and wood.

Old newspapers and board are dumped into a pulper, which breaks the material back into basic fibres, then these fibres are automatically moulded into the desired items with the aid of a vacuum. The items are dried in drying machines. Much of the water and heat involved in the process is recirculated.

2.1.3 Papier Mache

Papier mache is the process by which strips of paper are laid over a framework with the aid of a glue, and modelled to produce a hard item. The glue used for papier mache may simply be a mixture of flour and water.

The idea of using newspaper for papier mache is gaining increasing favour with modern artists. According to Shannon (1989:4), "The twentieth century artist has been using paper as a 'found object' material and incorporating it into collage or sculpture. Graphic designers and illustrators exploit the qualities of paper. However, it is the artist craftsman who is extending the boundaries of traditional papermaking as an expressive medium".

Papier mache techniques can be used to make items of any shape or size. These items may also be very useful. The techniques to making papier mache have been adopted in the development of Appropriate Paper-based Technology (APT). APT was established in Zimbabwe in the 1970s to address financial constraints in the teaching of art in schools. Teachers were asked to encourage students to make strong, useful, attractive items from cheap and readily accessable art materials such as grass, clay, leaves, reeds and paper. Practical items such as desks, chairs, tables, stools, solar cookers, water heaters, fruit driers, stoves and wheelbarrows have been produced in schools and homes in Africa, the Middle East, India and the United Kingdom (see Figure 2). The advantages of the furniture made from this technology is that it is strong, there are no joints and it will not crack. Items such as dolls, playpens, kids furniture, trays and puppets are also made using this method. Polyurethane varnish can be used to ensure that the items produced have longevity, although this is not a necessity (Packer, undated).

Figure 2: Examples of Appropriate Paper Based Technology

Source: Packer, undated

2.2 Insulation

There has been increasing importance placed on the use of insulation in recent years, as it has a role in the efficient use of energy and a subsequent reduction in the levels of carbon dioxide in the environment. The burning of fossil fuels such as coal, oil and natural gas to produce energy for heating and electricity not only depletes non-renewable resources, but contributes to much of the increase in carbon dioxide levels in the environment. In turn, carbon dioxide contributes significantly to the Greenhouse Effect, which is expected to contribute to the warming of the earth and "fundamental changes to our life on this planet" (Australian Government 1991:6).

Insulation can reduce the demand for domestic heating, for example, by providing conditions for the efficient use of energy. Insulation prevents the heat loss by conduction which normally occurs through the roof, the walls or the floor of a building. Asbestos, wood, cellular plastics, seagrass, fibreglass, straw and newspaper can be used to make insulation.

Cellulose insulation is made from new or used newspaper which has been shredded and hammermilled (see Figure 3). It is resistant to fire and vermin due to the addition of borax and boric acid. This fluffy wool-like substance has good thermal insulating properties due to the presence of a great number of small cells of relatively still air (Tye 1974:176). The product can be applied pneumatically as a fluffy substance (see Figure 3) or it can be mixed with a plastic binder to form a spray-on insulation, whereby there is a higher density than the loose fill without significant impairment to the thermal resistance.

The effectiveness of materials as thermal insulators are measured by their thermal resistance, or R-value. The higher the R-value, the more effective the insulator. Cellulose insulation, at a thickness of 100mm, has an R-value of 2.5. This value compares to the insulating value of mineral wool and fibreglass batts installed at a thickness of 120-150 mm (Hydro-Electric Commission 1984:5).

Unlike many of the more conventional forms of insulating material, there are "no significant health effects" arising from the use of cellulose insulation (Hydro-Electric Commission 1984:10). Fibreglass insulation can produce skin and eye irritation. Mechanical injury to the skin and mucous membranes from handling fibreglass insulation can cause respiratory tract irritation (Hydro-Electric Commission 1984:9). It is necessary to exercise great care in the application of fibreglass, polyurethane and urea-formaldehyde (which has recently been banned). There has been suggestion that glass fibres of the size found in rockwool and fibreglass may be linked to cancer in rats, although further investigation is necessary (Hydro-Electric Commission 1984:10). Polyurethane insulation contains toxic isocyanates. Formaldehyde gas causes irritation of the mucous membranes of the nose, eyes and upper respiratory tract. Skin problems have been reported after exposure to urea-formaldehyde (Hydro-Electric Commission 1984:10). There is some community concern regarding the effects of long-term exposure to these conventional forms of insulation (R. Alliston, Toxic Action Network, pers. comm.)

Comparatively, the health effects of installation and utilisation of cellulose insulation are minimal. It is possible that the borate salts which are added to cellulose insulation as a flame retardant can be toxic if ingested (Hydro-Electric Commission 1984:10). These salts can be absorbed by the skin, so the installation of cellulose insulation requires the use of gloves. As there is a lot of dust generated when installing cellulose insulation, it is advised that those who install the insulation also wear a face mask (Hydro-Electric Commission 1984:10). As with the installation of any insulating material, it is advisable to seal all manhole covers, gaps and spaces, preventing dust from entering living spaces. Concern has been expressed over the vapourisation of boric acid, but laboratory study has shown that it would take hundreds of years at 70^{o}C and 100% relative humidity to lose a detectable amount of boric acid (Yarbrough 1990).

Cellulose insulation is lightweight: when installed to a thickness of 100mm the fibre weighs 3-4 kg per square metre, which means that there will be little strain on the ceiling. If cellulose insulation is properly treated, it will not gain weight from absorption of water. The cellulose insulation industry suggests that cellulose insulation is 'mildew proof', as it "does not absorb moisture, eliminating problems such as black mould on ceilings by starving the fungus of dampness required for it's growth" (Cool or Cosy Insulation Services). It is also claimed that cellulose insulation does not blow around or pack down, although it has been suggested that cellulose insulation can compact over time, reducing its insulation value (Hydro-Electric Commission 1984:6). The general manager of 'Charlie Fluf' insulation, produced in Tasmania, suggests that, when correctly installed, compaction is minimal over a long period, but indicates that if a small amount of additional cellulose insulation is added to the 100mm usually placed in the ceiling, then the problem of compaction is alleviated, and the insulation value is not compromised (G. Hanna, 'Charlie Fluf', pers. comm.). Conclusive experimental research on the likelihood of compaction and its effect on insulating properties was not found. The possibility of the combination of borax and boric acid to cause corrosion of metals can be reduced by the addition of hydrated lime and sodium carbonate (Fibre Fluf Home Insulation).

There is some opposition to statements made by the cellulose insulation manufacturers, and some of these statements may be given credence in instances where there may be some inconsistencies in the quality of cellulose insulation. Tye (1974:176) acknowledges that differences in raw materials and their processing can have a significant effect on the properties of the insulation. It is recommended that strict measures are undertaken in the area of quality control, to ensure that the product is of consistently high quality. This may play a role in ensuring consistent demand for the product.

Standards for the quality of insulating materials must be met under Australian Standard number AS 2464 "Cellulosic Fibre Thermal Insulation". Tests are required to be undertaken on cellulose insulation with regard to fire hazards associated with insulating material, and the results must comply with the Australian Standard AS 1530 Part 3 (1982), entitled "Tests for Early Fire Hazard Properties of Materials". Fire risk is an important consideration when purchasing insulating materials. The cellulose insulation manufacturers suggest that cellulose insulation has "exceptional fire retarding qualities" (Cool or Cosy Insulation Services). Graham Hanna from 'Charlie Fluf' insulation in Tasmania indicates that the spread of fire where cellulose insulation is in the ceiling is reduced compared to the spread of fire where fibreglass is in the ceiling, although no published technical information has been found to support this view.

There are environmental advantages in using cellulose insulation compared to the use of insulating products such as polyurethane foam or extruded polystyrene. This is because the latter products are often blown with chlorofluorocarbons, which are Greenhouse gases and cause problems for the ozone layer (Australian Government 1991:22).

Overall, an assessment of the environmental and health advantages of the use of cellulose insulation would indicate that there is case for the preferential installation of this type of insulation in homes and other buildings. The use of cellulose insulation provides an avenue for sensible and appropriate use of old newspapers.

Figure 3: Installation of Cellulose Insulation, indicating the appearance and texture of hammermilled newspaper

2.3 Agricultural and Horticultural Purposes

There is potential for newspaper to be used for horticultural and agricultural purposes. If the consumption of newspaper cannot be reduced, and it is impossible to recycle or reprocess newspaper at a low environmental cost, newspaper can be incorporated into the domestic composting facility, or it can be used as a garden mulch. Newspaper can also be used as a bulking agent for the production of marketable products such as compost which has been produced on a large scale, or hydromulch for rehabilitation purposes (with or without agricultural or sewage wastes). Newspaper can be used as a source of food for worm farming. Earthworms can be used for fish bait, as a source of protein for the diets of fish and poultry, and there is the potential for earthworms to produce protein for the food and pharmaceutical industries. Earthworms can be used as efficient organic waste converters, and the high quality soil amendment produced by earthworms can be marketed. Due to the high cellulose content of newspaper, there is the possibility that newspaper can be fed to ruminant animals as a source of nutrition. The commercial viability of these options will be discussed in sections 3.5.1 to 3.5.7.

2.3.1 Domestic Composting

In Chapter 1, the observation was made that newspaper does not automatically degrade when buried in landfill. It is possible to encourage the biodegradation of newspaper, however, by incorporating it into the household composting facility. Compost can be produced from organic material such as kitchen wastes, garden wastes, paper and cardboard, sawdust and wood shavings, animal manure, woodfire ash and seaweed. Goldberg (1991:54) indicates that paper can act as a suitable bulking agent in compost. It may be suitable that up to 10% of the material entering a composting arrangement could be newspaper. It is important that newspaper is shredded before application to the compost pile to ensure adequate decomposition.

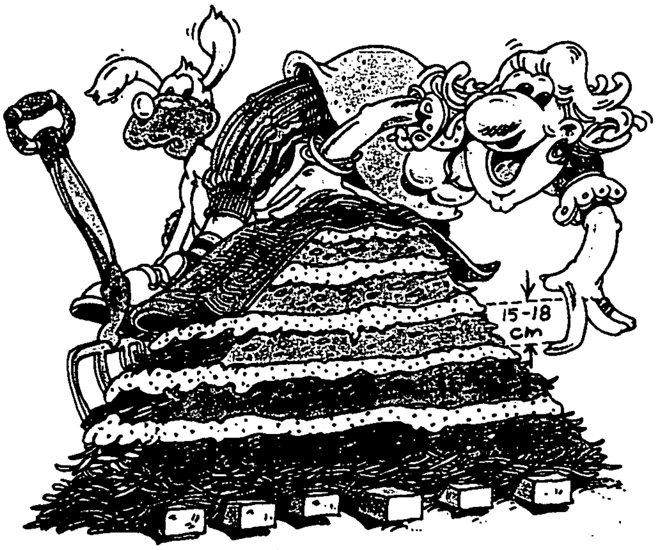
The composting process can be defined as "the biological degradation of organic materials under anaerobic conditions by micro-organisms operating at thermophilic temperatures"(Klatt 1990:43). If air, moisture and nutrient levels are favourable, temperature may exceed 45°C which determines the dominance of a special group of thermophilic micro-organisms. The main organisms operating in the compost heap are bacteria, fungi and actinomycetes. It is these thermophilic organisms which are responsible for the decomposition of organic matter.

Making compost is not particularly difficult for the householder, but there is a certain amount of care which must be taken to ensure that the conditions required for the production of compost are met. Compost can be made in a compost heap or in a compost bin in a garden, depending on the needs of the householder. For gardeners having large quantities of waste to decompose, a compost heap is most suitable (see Figure 4). The minimum dimensions of the floor should be one metre square and about one metre high. The heap may be partially enclosed by bricks or by timber, but space is required in the front of the heap for turning the compost. A compost heap should be built up in layers of about 150mm. With the addition of a layer of compostable matter, which must be moistened if dry, a thin layer of lime should be sprinkled over the top, then the heap should be covered with a thin layer of soil to avoid attracting flies and releasing odour. Turning the heap with a fork can speed up the rate of decomposition: if the compost heap is turned every third day after being built, the compost should be ready for use after a fortnight. If left unturned, the composting process may take up to a year (Victorian Environment Protection Authority, undated)

Mature compost has many benefits for the soil: it is rich in organic matter and is valued for use in horticulture and agriculture. Even at very low concentrations, humic acids found in compost have been proven to stimulate growth in plant crops. Compost can improve aeration in the soil, neutralise toxins, alter the acidity of the soil, and improve the colour of flowers (Minnich and Hunt 1979:30). Mature compost can be used as a soil conditioner, improving soil structure, retaining moisture, binding nutrients and reducing soil erosion. Compost can also be used as a mulch, smothering small weeds and preventing drying, and as a peat substitute in potting mixtures (WARMER 1990b).

The advantages of composting newspaper in the domestic compost pile include reducing household waste, saving money on waste disposal, and reducing backyard incineration. The use of chemical fertilisers can be avoided if compost is used on the garden.

Figure 4: Profile of a domestic compost heap



Home composting is even being investigated in multi-storey buildings in New York using small scale, in vessel composting systems (Goldberg 1991:53)

2.3.2 Large-Scale Composting

Along with the development and promotion of small scale domestic composting operations, large scale composting operations could be established to deal with waste newspaper. In France there are around 95 large-scale composting plants, which produce 650,000 tonnes of compost per year using a variety of methods. In Poland, there is a composting plant which can produce about 50 tonnes of compost per day for use in city parks. Composting plants process 25% of the domestic waste in Leningrad and Minsk (WARMER 1990b). In West Germany in 1988 there were more than 71 facilities to process source separated organic waste, which served 430,000 homes and composted 90 kilograms of compostable wastes per person per year (Industry Commission 1990c:132).

There are three main categories of large-scale composting. Windrow composting, which is the least technologically based form of large-scale composting, uses mechanical turning to aerate the composting waste, which is placed in heaps about two metres high. Forced aeration systems require the waste to be piled over a ventilated floor area or perforated pipe, and air is supplied to the heap. Air can either be blown out of the pipes, whereby heat at the centre of the heap is distributed to the outer, cooler regions, or air may be sucked in towards through the waste, which allows for odours to be contained. The third form of large-scale composting is the enclosed reactor system, whereby close monitoring of temperature, moisture, mixing rates and aeration can be undertaken (WARMER 1990b).

In order to enable the effective decomposition of paper in large scale composting operations, research could be undertaken in the development of new technologies in decomposition which could include the selection of "super" microbial strains to degrade wood and paper products more efficiently. It may be possible to use fertilisers and other amendments to stimulate microbial growth (Setterholm 1991:84): once the microbial growth has been stimulated, the possibility of incorporating large amounts of newspaper into compost exists.

2.3.3 Garden Mulch

Newspaper can be used in domestic gardens as a mulch. Mulch is used to moderate soil temperature by preventing excessive drying of the soil. It is also used to prevent excessive leaching of soil nutrients. A mixture of shredded newspaper, blood and bone fertiliser, household food scraps and grass clippings, along with compost has been recommended as a suitable mulch to use on the garden (TRALAC 1991:2).

Layers of moist sheets of newspaper are often laid down under garden beds to assist in the control of weeds (TRALAC 1991:2).

2.3.4 Commercial Mulch

Hydromulch is a material which was developed in the 1950s in England, and is used commercially as part of the process of rehabilitating degenerated land. It is particularly useful in areas which are potentially eroding. As well as mulching the soil, hydromulch stabilises the soil, prevents rain splash and provides a stable bed in which seedlings can become established.

Hydromulch is a mixture of shredded wood fibre or newspaper with fertiliser, water, and a binding agent, such as Plantac, an extract of plant material. Wood fibre is often chosen in preference to newspaper as it is easier to apply and may be more well suited to the type of rehabilitation which is being undertaken. Nevertheless, newspaper is suitable for many applications. High swelling clay derivatives such as bentanite can also be used to facilitate binding of the mulch to the soil. Seeds can be added to the hydromulch, and are effectively stuck to the soil when this mixture is sprayed onto the ground, ensuring that even in wet weather conditions where there is normally high runoff, the seeds have the chance to germinate and grow (T. Duckett, Land Rehabilitation Services, pers. comm.). The establishment of vegetation in the area is an important part of rehabilitation of the land.

It is important to note that a site which is to be rehabilitated must be prepared by ensuring minimal disturbance to the soil, conserving the topsoil, providing adequate drainage for the soil, and then applying hydromulch. It is important to provide enough water to the mulch. Maintaining adequate levels of fertiliser is also important. This may mean that, at six monthly intervals, fertiliser must be re-applied, as it may have been used by the growing vegetation (T. Duckett, Land Rehabilitation Services, pers. comm.). Hydromulch must be applied at an appropriate time of the year: when there is adequate rainfall to ensure that the mulch will not dry out, and at an appropriate time of the year for seeds to germinate.

Hydromulch is generally applied to a thickness of approximately 5 mm, although the amount used depends on the type of rehabilitation work to be performed. To one hectare of flat land, only 25-30 kg of hydromulch may be required. To a loose soil, it is possible that 1,000 kg of hydromulch will be used on one hectare, and to a sandy soil with high exposure to winds, 2,500 kg of hydromulch may be applied to one hectare (T. Duckett, Land Rehabiitation Services, pers. comm.).

Hydromulch technology can be used for application to various soil types and under various conditions. Waste newspaper, combined with binders, seed and other materials has been used to aid the growth of vegetation on the desert soils of Kuwait. Many hundreds of tonnes of used newspapers were used over several years in these projects, which included the establishment of garden beds on government commissions, and playgrounds. In Kuwait, there was also much emphasis on the use of this technique for sand stabilisation projects. Waste materials other than newspaper which were used in these projects included building rubble waste, which was used for the establishment of hills in playgrounds. Newsprint was applied at a rate of 200 grams per square metre. Tackifiers, green tint and special binding agents were also used (Urquhart 1990:1).

Recently the PNEB has funded the Cygnet Recyclers Co-operative to establish a local industry to manufacture mulch mats from waste newsprint in Tasmania (PNEB 1991b). In New South Wales, University Partnerships are conducting marketing trials for the Treestart Disc, a collar shaped pad made from newsprint. These discs have fertiliser embedded in them, which means that they mulch the soil while protecting and fertilising young trees. The PNEB has also funded hydromulching projects in New South Wales (PNEB 1991b).

2.3.5 <u>Newspaper Mulch with Sewage as Fertiliser</u>

The disposal of sewage is an important issue for human and environmental health. The most common method of sewage disposal is primary treatment of sewage, whereby screening and gravity treatment of sewage are undertaken. The solid material removed in sedimentation is called primary sludge. Pollutants and nutrients are not removed when sludge is removed, and remain in the waste water. Pathogen levels of primary sludge can be reduced by microbial action in anaerobic digesters (Awad *et al.* 1989:1). As pollutants and nutrients are not removed by primary treatment, subsequent release of the waste water into oceans is harmful to the aquatic environment. Secondary treatment involves the use of waste water treatment reactors where bacteria break down organic matter and solids settle out, forming activated sludge (Awad *et al.* 1989:1). Nutrients are not removed by secondary treatment, and disposal of secondary treated sewage effluent into waterways is also unsatisfactory for the health of the waterways. Tertiary treatment is rarely undertaken due to the cost involved with the process. Even when tertiary treatment is undertaken, if this treated water enters the sea there may be environmental drawbacks on native organisms due to the presence of disinfectants such as chlorine in the effluent.

Sewage does not need to enter waterways or the sea. The application of sewage sludge to land has many benefits. Sewage sludges contain 40-60% organic matter. Organic matter binds together soil particles into aggregates, improving soil structure, and it creates large pores through which water and air can move. Overall, this raises the water holding capacity of the soil. Most Australian soils contain less than 5% organic matter, which is about half of the level which is considered desirable (Awad *et al.* 1989:2). Sewage sludge is rich in nutrients such as phosphorous, calcium, magnesium and nitrogen, which are all needed for plant growth. Sewage sludge contains higher levels of nutrients than other forms of organic wastes, such as poultry and piggery manures, with the exception of potassium. With respect to crop yields, sewage sludge is more productive than inorganic fertilisers. Grazing trials have shown that wool production, number of lambs born, weaning weights and health of sheep were in no way adversely affected by using sewage sludge on the grazing pastures (Awad *et al.* 1989:2).

There has recently been a move towards the development of techniques to use sewage sludge for agricultural and horticultural purposes. Sewage sludge and/or farm wastes can be combined with waste newsprint to make an ideal mulch for horticultural or agricultural purposes.

Many organisations have appreciated the benefits of using other waste materials, such as paper and wood fibre, for such purposes. Sewage is treated at the Sewage Treatment plant at Ulverstone, Tasmania, and composted with sawdust to make an ideal mulch for application to local lawns and nature strips (Stan Richardson, Sewage Treatment Plant, Ulverstone, pers. comm.). 'Aquaseeding', a company in Melbourne, used sewage sludge from Carrum Downs sewage treatment plant. Between 200-700 kg of sludge is applied per hectare, depending on the need for fertiliser. This sludge, which had been treated in lagoons for a period of seven years, was obtained free of charge and added to the mixture of newspaper or wood fibre, bentanite, seed and water in hydromulch. This sewage sludge, resembling a loamy soil, was odourless and friable, which was found to be suitable for application as a component of hydromulch. Used newsprint and sewage sludge were combined in a successful vegetation planting program in Kuwait (Urquhart 1990:1). Australian Native Landscapes Pty Ltd, is taking large volumes (60,000 cubic metres per year) of Sydney's sewage sludge, combining it with waste materials from the forestry industry, including sawdust and wood shavings, and converting it into a valuable humus which is used in the landscape and horticulture industries (Anon 1991a:22). It may be possible to use waste newspaper as a substitute for wood fibre in this application.

Australian soils have thin, seasonally hardsetting topsoils, which overlie dense subsoils of low porosity (Anon 1991a:24). Since the soil is often hardsetting, there is a reduction in the capacity of the soil to absorb and retain sludge. This means that run-off can occur. The fact that these soil properties exist is one reason to encourage the use of hydromulch as a stabilising agent, preventing run-off, and sewage as a soil conditioner.

Sewage can be treated in various ways in order to be able to be used in combination with newspaper for agricultural and horticultural applications. The sewage used by 'Aquaseeding' was primary treated and placed into a sludge lagoon for 5-10 years. Anaerobic conditions exist on the floor of a lagoon whereby anaerobic micro-organisms digest the sludge and produce a solid material rich in nitrogen, phosphorous and potassium. The lagoon was drained and the dried sludge was ready to collect and apply. Some sewage treatment plants undertake treatment known as anaerobic sludge treatment. Primary sludge is put into a chamber for 30-60 days, whereby temperatures of 35-38°C are sought. This sludge then undergoes secondary digestion whereby the sludge is thickened and stabilised. There is the opportunity to stockpile this sludge into compost heaps for 6 months. If composting is undertaken, the high temperatures attained may eliminate harmful spore-forming anaerobes (A. Ferguson, Self's Point Sewage Treatment Plant, pers. comm.). The material produced is very concentrated, and could also be applied in combination with hydromulch. In order to make the mulch at the sewage treatment plant at Ulverstone, activated sludge was aerated in a tank for 20 days, dewatered by a belt drier, and composted in the open with sawdust. The heap was turned regularly. The temperature of the composting heap was tested, and it was important to establish a temperature of 43°C for at least three days to kill pathogens. After two years of composting, the mulch was tested for faecal coliforms. If the level of faecal coliforms was low enough, the mulch was allowed to be sold for use on lawns and nature strips to local residents (Stan Richardson, Sewage Treatment Plant, Ulverstone, pers. comm.).

An important consideration in the utilisation of sewage sludge in horticultural and agricultural applications is that environmental and human health must be safeguarded. There are pathogens, heavy metals and organic pollutants in sewage sludge, which need to be dealt with adequately before any sewage is used on Australian soils. The State Pollution Control Commission in New South Wales, the Department of Water Resources, the New South Wales Department of Health and the New South Wales Department of Agriculture and Fisheries have established guidelines for the use of wet sludge in New South Wales (Awad *et al.* 1990:24). Such controls also would need to be adhered to for the application of dried sludge. These guidelines include recommendations concerning the avoidance of application of sludge with excessive heavy metal content, monitoring and restriction of sewage containing certain organic compounds such as pesticides, inactivation of viruses, bacteria and protozoans, and the suitability of exposing certain animals to soils which have been treated with sewage. The guidelines also include recommendations on the type of sites on which to apply sewage sludge, the rate of application of sewage, transport, handling and storage of sewage sludge, and how to monitor the soils, plants, water and animals which are exposed to the sludge.

These guidelines have been established to address the problems with the application of sewage sludge to Australian soils, where Australian conditions preclude the immediate application of research results and techniques developed overseas. The application of newspaper and clay to sewage sludge can be an environmentally acceptable method of disposal for sewage wastes, assuming that strict guidelines on the treatment of sewage are adhered to, and that sewage and mulch is applied carefully. For health reasons, sewage sludge with high levels of heavy metals and pathogens should not be used for crops or where food is to be consumed by humans. Sewage, in combination with newspaper and clay has potential to be successfully used in revegetation projects, forest plantations and for horticulture. Using waste newspaper in such a way is an avenue for appropriate use of this material.

2.3.6 Feeding Earthworms

Earthworms may be used to partially alleviate the problems of disposal of food scraps and newspapers. Earthworms are saprophages: they feed on organic wastes, usually the decomposing leaves and stems of plants, although root material, seeds, fungi, protozoa and algae may also be ingested. Usually, the more decomposed a material is, the more rapid the digestion. It has been suggested that "earthworms will feed on anything they can find in their environment that is organic in nature" (Piearce 1978 cited in Wallwork 1983:10). In this way, newspaper could be used to feed to worms.

There are different types of earthworm, which eat different sized particles at different stages of decomposition. Bouche (in Wallwork 1983:10) has classified worms into microphages, mesophages and macrophages. The latter, including such species as *Lumbricus terrestris, Allolobophora longa* and *Octolasion* species consume between 10% and 30% of their live body weight per day. Digestive enzymes are responsible for the digestion and absorption of food: the enzymes recorded in the digestive tract of many earthworms include cellulase, which is responsible for the breakdown of cellulose (Laverack, 1963 cited in Wallwork 1983:14). The presence of cellulase enzyme in earthworms may have important implications in considering an appropriate disposal or reprocessing mechanism for newspaper, which has a very high composition of cellulose (Porteous 1977:95).

Earthworms are found naturally in manure piles, compost heaps, or decaying leaves. Earthworms are important because they convert organic material into stabilised humus. Soil fertility is increased, hence plant growth is encouraged. Their tunnels and castings ameliorate the soil structure and enhance microbial activity. The castings of earthworms are an important source of nutrients (Reijntjes 1984:139). Earthworms also influence the acidity of the soil and improve the texture of the soil (Wallwork 1983:15).

Worm 'farms' have been established in many areas, and either the worms or the castings produced by the worms can be sold for use in gardens. Instant Vegi Gardens, a small operation in Cygnet, Tasmania, uses newspaper as a medium for the growth of worms. The castings and worms which result are sold to gardeners or used by the business in the establishment of gardens. Various methods can be used to 'propagate' worms. One method is used by Instant Vegi Gardens whereby different sorts of paper and board are placed in a drum, which is filled with water. The paper in this drum is left to saturate for up to a month. Layers of this mixture, manure and a starter 'culture' of worms are made in a small pit surrounded by hay or old carpet. Moisture levels are monitored to ensure that there is no drying out. After a certain amount of time, a fertile mixture of castings is produced, and this is ready to be applied on gardens.

Due to the fact that they deal with organic wastes so well, earthworms have been used by many organisations as a way of dealing with organic waste. A co-operative of earthworm farmers in Holland uses domestic organic waste or horse and cow manure as the basic material for the propagation of earthworms. Both earthworms and the vermicompost which are produced are marketed. Earthworms are appreciated for their high protein content, and can be used as a fish bait and in the diets of fish and poultry (Reijntjes 1984:139).

Vermicomposting systems are in use in the United States. Vermicomposting systems are actually worm bins or worm farms which are dark, tightly closed boxes housing red manure worms. Any container with a tight-fitting lid is suitable for housing a worm farm, or vermicomposting system. In the office of the King County's Solid Waste Division (KCSWD) in the United States, the worm bin doubles as a bench in the reception area, and selected lunch scraps from the office workers, including banana peels, coffee grinds, bread crusts, rice, broccoli, zucchini, grapes, apple cores and paper napkins, are fed to the worms. There is no odour from the worm bin, and the worms consume about 7.5 litres of food every day. The KCSWD planned to introduce worm composting systems to 100 schools in the area by the end of 1991: the idea is that children can observe vermicomposting in their classrooms (Combs 1990:117).

Potential exists for earthworms to be used more comprehensively for the breakdown of newspaper. Where markets for fish food, protein for fish and poultry diets, earthworms and vermicompost can be developed, the justification for using newspaper as a source of food for these organisms exists.

2.3.7 <u>Animal Bedding</u>

Newspaper which has been shredded or cut into small disks, about 20 mm in diameter, can be used to replace straw as a form of animal bedding.

In Australia, newspapers have been shredded and used as bedding for the in-vitro fertilisation project of the Commonwealth Scientific and Industrial Research Organisation. The Brotherhood of St. Lawrence produced newspaper-based animal bedding, and this was mainly used for horses and greyhounds. Paper Shredders in Sydney have developed a safe form of chicken bedding from newspaper.

There could be a place for a much enhanced use of newspaper as a source of animal bedding, particularly in situations akin to the 'straw crisis' in the U.S. prior to 1979 (OECD 1979:128). Goldberg (1989:38) indicates that animal bedding made from newspaper lasts as long or longer than straw, and is gentler to the sensitive hooves of horses and cattle. Paper bedding is more absorbent than straw, and can later be mashed for fertiliser (OECD 1979:128).

2.3.8 <u>Animal Fodder</u>

It has been stated that of the 260 million tonnes of urban wastes generated in the U.S. in 1971, about 50% was paper or paper products. The cellulose content in this waste was estimated as about 85 million tonnes (Shuler 1980:24). Cellulose is a major component of the ruminant's diet. Due to the high cellulose content and accessibility of waste paper, analysis of the digestibility and acceptability of newspaper as a feedstock for ruminant animals has been undertaken. Upon investigation, waste paper has been looked upon as a convenient source of energy for ruminants, and a way of dealing with paper waste.

In the forestomach of ruminants such as cattle and sheep, the gut is large enough to slow the passage of food, there is mixing of the food, rumination and copious amounts of saliva present. These are the conditions which are necessary for the propagation of the very complex mixture of microorganisms including protozoa and bacteria. These micro-organisms contain enzymes called cellulases which break down cellulose (Lassiter and Edwards 1982:18). The end products of the fermentation of cellulose and related substances of the plant cell walls serve as ready energy sources for the animal.

The composition of stockfeed will vary according to the cost of the materials which are available, but the energy and protein values are generally not compromised. In the production of animal feedstock, about 10-20% is comprised of materials which provide roughage, such as oats, straw and hay. It is possible that newspaper could be used to supplement or replace oats, straw or hay. Molasses can be added to improve the acceptability of newspaper rations (Sherrod and Hansen 1973:592-596). The remainder of the feedstock pellets may be comprised of materials such as wheat, barley, wheaten pollard, wheaten bran, sunflour meal, soya meals, lupins, vitamins and minerals, and there may be a component of high protein feed such as fishmeal or meatmeal (Geoff Tuting, Monds and Affleck Stockfeeds, pers. comm., Tim Swan, Gibsons Stockfeeds, pers. comm.). If there is no protein added to a diet, urea in the fodder can provide a source of nitrogen which is necessary for the micro-organisms in the gut to produce a source of protein (Coombe and Briggs 1974a:301).

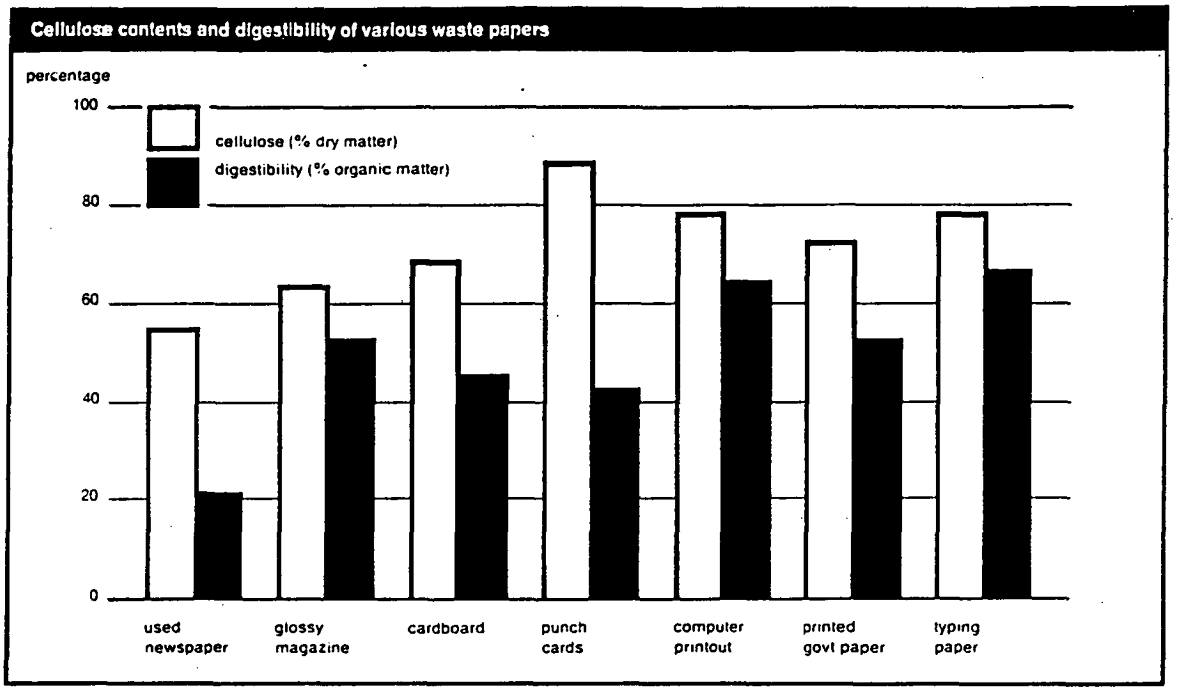
Several papers have been published regarding the use of paper as a component in feedstock. Dinius and Oltjen (1971:1345) reported that the average weight gain of steers was not significantly affected by the addition of 8% newsprint in a ration as compared to the control (given no newsprint). When treatment involved feeding the steers 16-24% newsprint, the steers did not gain weight. Where the effects of a high grain diet containing 10% newspaper were compared to the effects of feeding a high grain diet containing 10% hay, there was no significant difference in the carcass grade of the finishing steers (Dinius and Oltjen 1971:1348). Daniels *et al.* (1970:595) indicate that ground newspaper can replace at least 12% of the diet of growing steers without affecting the efficiency of feed, carcass grade, the rate of weight gain, and the flavour and tenderness of the beef. Newspaper was compared as a source of roughage to sudan hay. Average daily weight gains were comparable for heifers fed the control (sudan hay) and the heifers fed the 3.3% newspaper ration (Sherrod and Hansen 1973:592). Razzaque *et al.* (1984:34) indicated that sheep were able to digest the cellulose in cardboard more effectively than the cellulose in ryegrass straw.

It would appear, from the literature, that newspaper could supplement approximately 10% of the the diet of a ruminant without detrimental effects to the carcass grade of the animal. There is also the possibility that newspaper could be treated in order to make it more digestible and palatable for the animal. As such, it could be possible to increase the amount of newspaper in the feedstock without providing discomfort to the animal or degrading the quality of the meat.

From many studies it can be shown that ruminants can digest other varieties of paper with much greater success than newspaper. Coombe and Briggs (1974a:292-301) indicate that mature sheep gained weight when fed on pellets containing 65% waste office paper, 32% linseed meal and 3% minerals, provided that roughage in the form of chaffed hay was also fed to the animal. Other trials undertaken by Coombe and Briggs (1974a:301) involved a test of weight gain of mature sheep fed on pellets made from 84% waste paper, 8.4% molasses, 3.6% urea and 4% minerals, with or without the addition of lucerne to the diet. Overall, results indicated that sheep fed a combination of lucerne and office paper pellets in the first seven weeks of the trial actually gained weight, but not as much as the control group, fed on pure lucerne and lucerne pellets. Sheep which were fed on lucerne and pellets made from a combination of 42% office paper and 42% newspaper were found to lose weight. The intake of pellets was severely reduced when newspaper was included in the pellets. There was particularly rapid weight loss when, in the eighth and ninth weeks, sheep were fed on office paper/newspaper pellets and no chaff was given (Coombe and Briggs 1974a:301).

From Figure 5, it would appear that the palatability and digestibility of newspaper is lower than that of office paper. Ruminants are less attracted to newspaper as a source of food compared to office paper. Coombe and Briggs (1974a:299) suggest that the depressing effect of newspaper on consumption may have been due to gut fill, possibly because of the water holding capacity of newspaper. One reference suggests that this gut fill causes discomfort, and that animals quickly learn to avoid this food (Anon 1991b:21). Evidence of low digestibility of newspaper can be shown by the weight loss in sheep when fed on a diet of newspaper, compared to the office paper. The mean organic matter digestibility of office paper was found to be 65%, compared to a mean digestibility of newspaper of 22% (Coombe and Briggs 1974a:301). Other references cite the organic matter digestibility of newspaper as being in the range of 20 to 29.7% (Anon 1991b:21, Sherrod and Hansen 1973:592, Dinius and Oltjen 1971:1346).

Figure 5: The Relative Digestibility of Newspaper



Most types of paper contain a high proportion of energy-giving cellulose in a form that ruminants can use.

Source: Coombe and Briggs (1974b:25)

The level of digestibility of paper appears to be dependent upon the amount of lignin in the paper: the more lignin, the less digestible the paper will be. Past research has generally found that wood pulp has a high digestibility when the lignin content is below 5% (Baker 1973:768). Newspaper has a high content of lignin compared to office paper, hence is more indigestible than office paper.

Cellulose and hemicelluloses occur along with lignin in the plant cell wall. They are associated with lignin in variable and not yet understood ways. In highly lignified wood, cellulose is completely indigestible. On the other hand, cellulose is readily digested in leaves having low lignin content. Hemicelluloses are nutritionally important also, comprising up to 20% of the dry matter of some feeds. Potentially, they are probably completely fermentable in the rumen if not combined with lignin (Lassiter and Edwards 1982:46).

In terms of paper processing, the level of digestibility is directly related to the process by which the paper is produced. Using chemical paper processing, for example, to make office paper, encourages the removal of lignin. The thermomechanical production of newspaper does not encourage the destruction of lignin, to which cellulose is bound. This undigestible portion of carbohydrate is immediately found in the faeces, without being broken down by the gut microflora. No energy can be derived from lignin (Lassiter and Edwards 1982:46).

Experimental work has been undertaken which indicates that the digestibility of cellulose can be increased by physical and chemical means. The lignin in newspaper can be treated to remove the cellulose and therefore improve the digestibility of the cellulose. There can be pretreatment of lignin, whereby some process is applied to the material which will not cause extensive hydrolysis of cellulose, but will increase the reactivity of cellulose to the subsequent application of hydrolytic agents. Physical treatment processes for breaking down lignin and releasing cellulose include milling, irradiation and heat and pressure. Chemical treatment processes include the use of sodium hydroxide, sulfur dioxide and cellulose solvent systems (Shuler 1980:44-47).

2.3.6.1 Increasing the Digestibility of Newspaper by Physical Treatment

1. Milling

Grinding and cutting are commonly used processes to increase digestibility and are employed in order to acheive an increase in the surface area of the cellulose-containing food sources being treated. Two-roll milling is also an effective treatment for increasing the susceptibility of cellulose to enzymatic hydrolysis. Ball milling of newspaper prior to a 24 hour cellulase digestion (in vitro) gave a 62% increase in cellulose digestion compared to a 125% increase in cellulose digestion obtained from two-roll milling for an equal time (Shuler 1980:44). There is almost a linear increase in digestibility with an increase in milling time.

2. Irradiation

Gamma ray or electron irradiation is an effective treatment for improving the digestibuility of cellulosics by rumen organisms.

3. Heat and Pressure

Heat and pressure can be applied to aspen chips for 2 hours at 100-115 psi at 160-170°C to give a product which is readily accepted by sheep (Shuler 1980:44). Other lignocelluloses such as in newspaper can be loaded into a high-pressure chamber and steam is injected until the temperature of the material is above 230°C. Soon after the material reaches this temperature it is removed from the chamber through a small dye and is quickly cooled. Lignin is disassociated from the cellulose and forms small spheres upon cooling, which can be isolated from the residual fibre. The quick release of pressure causes disruption to the physical structure of the cellulose and produces a fibre which can be digested more easily (Shuler 1980:45).

2.3.θ.2 Increasing the Digestibility of Newspaper by Chemical Treatment

1. Sodium Hydroxide

The use of sodium hydroxide is the oldest and best known of the methods of increasing digestibility of wood fibres by chemical means. Shuler (1980:45) and Feist *et al.* (1970:832) report that many workers have found that the digestibility of lignocelluloses and hardwoods by cellulases and rumen-inhabiting bacteria was improved after pretreatment with dilute sodium hydroxide. Sodium hydroxide treatments used by Fiest and co-workers consisted of slurrying hardwoods at room temperature with 0.5 or 1% sodium hydroxide solutions. When there is an increased ratio of alkali to wood, there is an increase in digestibility. The minimum ratio at the maximum digestibility is about 5 to 6 grams of sodium hydroxide per 100 grams of wood (Feist *et al.* 1970:835). Sodium hydroxide is inexpensive at a concentration of 1% and treatment conditions are mild, as they are at room temperature. Slight neutralisation by acid may be a preliminary treatment to assist with the breakdown of lignin, hence the improvement of the digestibility of wood.

It is likely that appropriate application of sodium hydroxide as a treatment for newspaper could increase the digestibility of this paper for ruminants.

2. Sulphur Dioxide

Treatment with sulphur dioxide at 120°C for 2-3 hours results in a severalfold increase in digestion. Adeyiga (cited in Shuler 1980:46) studied the digestibility of minicipal waste fibre samples treated with sulphur dioxide, and it was concluded that there was an increase in digestibility to a certain extent, although not to the same degree as with other materials which contain cellulose.

3. Other Chemical Treatments

In the 19th century there was a patent application on the treatment of straw with aqueous ammonia. Aspen increases in digestibility dramatically upon treatment with ammonia (Shuler 1980:47). Hydrogen peroxide increased the digestion of cellulose by cellulase in the presence of iron (Shuler 1980:47). By soaking newsprint in a mild solution of hydrochloric acid and a small amount of hydrogen peroxide, and heating the paper to about 93°C, the digestibility of newspaper increased to 30-40% (Anon 1991b:21). (The length of time for saturation in hydrochloric acid was not provided in the latter reference).

Cellulose digestion is much less complete when the diet contains much starch or sugar. There is a rapid utilization of nutrients by the microbes which break down starch and sugar, and this limits the availability of nutrients to the microbes which break down cellulose (Lassiter and Edwards 1982:51). It is recommended that starch or sugar should not be fed to ruminants when a component of newspaper is in the diet.

The effects of treatment on the digestibility of newspaper in the rumen can be tested either by *in vitro, in vivo* or balance estimations. *In vitro*, or artificial rumen studies have been used extensively to evaluate the utilisation of feedstuffs. Essentially, the fermentation of rumen organisms with the test substrate e.g. newspaper, is established in a buffered medium for a period of time. The extent of fermentation of cellulose or dry matter is used to quantitate results (Church 1969:115). *In vivo* digestibility can be tested by suspending the treated feed in a nylon bag in an animal which has a fistula in its rumen. The digestibility of treated newspaper can also be calculated by the balance method, whereby the amount of paper which is consumed is compared to the amount of paper which exists in the faeces (the dry weight consumed minus the dry weight of the faeces). There is a reasonably high correlation of values for the *in vitro* digestibility with the *in vivo* digestibility (0.9 or better), indicating that *in vitro* digestibility can be used with a certain amount of accuracy to determine the digestibility of a certain foodstuff in the rumen of the animal, despite the departure from the natural processes involved in the rumen.

It may be possible that the lignin could be broken down by micro-organisms in a processing plant, for example, by deep fermentation. These micro-organisms could be those used to break down wood by-products in the soil, rather than those derived from the gut of the animal, as the latter is not able to digest lignin. A by-product of this fermentation, methane, could be used to power the plant. Residual micro-organisms and degraded newspaper could be used as fodder for animals.

Using artificial means of improving the digestibility can be one way to increase the use of waste newspaper. It is possible to use laboratory-based techniques to determine the digestibility of treated newspaper, and, in turn, to use effectively treated paper as a feedstock for ruminants.

There are many potential benefits to be gained by replacing some of the food which ruminants eat with a waste material, especially if the consumption of meat is to increase with an expanding population. One advantage cited by Sherrod and Hansen (1973:595) is that the carcasses of steers fed a ration of 12% newspaper in their foodstock had lower percentages of fat compared to those on a normal diet. Leaner meat is usually considered desirable as far as the prevention of heart disease in humans is concerned. If newspaper can replace some of the food which livestock normally consume, there may be a degree of relief from the problems associated with livestock production and fodder production, such as soil erosion, desertification, and the use of pesticides for fodder production. In using newspaper as a food source, it is possible that less land would be required for farming, and there may be a subsequent release on the pressure to use existing natural areas as grazing land. More land for the cultivation of grain and vegetable foods could become available, which may alleviate some of the pressure of feeding our expanding population, without encroaching on natural areas or further degrading marginal land. "Converting residues into a highly digestible ruminant feed would greatly increase our human food supply. For example, increasing the digestibility of these fibres to 80% would provide enough feed to double our present cattle population and subsequently release enough grain to feed 700 million people (based on 2400 kcal per person per day)" (Church 1969:33). "As demands increase on the food production sector to produce more food with higher energy efficiency, it becomes essential that technically and economically feasible means be found to use fibre more efficiently and more completely than at present to supply a greater part of the earth's need for food and fuel" (Shuler 1980:20). There is potential to use newspaper more effectively as a source of fibre for ruminant animals.

2.4 Building and Industrial Applications

The possibility of using newsprint as a building material has been investigated widely. Making building materials from newspaper may provide an alternative to the disposal of newspaper in landfill, and place it into long term use (Setterholm 1991:82). Using newspaper as a component of building materials may alleviate some of the pressures of using non-renewable resources such as stone and timber. There are a range of possibilities for using waste newsprint in building and industrial applications, and several of these applications can be shown in the following references.

2.4.1 Adhesive-Bonded Fibre Board

Particle board and fibre board has been made from woodchips, sawdust and other wood-based materials: developments could be made in the area of incorporating newspaper into such board (OECD 1979:128). In 1979, the OECD saw that there may be limits to the projected strength of the fibre board derived partially or fully from paper, but there was an appreciation that technological developments in the the future could lead to the possibility that fibrous board containing paper could be used for the diversity of applications to which fibreboard (produced from sawdust and woodchips) was being used.

It would appear that the technology exists for the incorporation of newspaper into fibreboard, and for this board to be comparable to that of traditional products. To date, most fibreboard has been excluded from structural applications because it has been unable to equal sawn timber or plywood in longitudinal stiffness, long term load carrying capacity and dimensional stability. The foreseeable decrease in the quality and availability of logs in the future has led to an increase in the amount of research into the application of adhesive-bonded board for structural applications.

> "Fortunately, recent developments, leading to combinations of particle alignment with the use of particles deliberately manufactured with optimum geometry, can provide materials equal to or surpassing conventional building materials in structural capability and reliability. These relatively new composition-board materials can also be easily modified by treating the particles with fire retardants, preservatives and stabilising impregnations" (Schnieweind 1989:217).

Traditionally, fibre board is made by either of two processes. Particle board, or dry-process fibre board, uses dry resins to bind lignocellulosic fibres. The production of wet-process fibre board requires the bonding of fibres with or without the use of bonding agents, using water as the processing medium (Schnieweind 1989:217). The term 'fibre' is used to encompass any wood or other lignocellulosic element possessing the size and shape of the wood cell (Schnieweind 1989:131). Hence, it is possible that newspaper could be used as a source of fibre.

Dry-process fibre board production generally uses the lower-quality end of the available range of wood material. Hence, flakes of wood, planer shavings and fine fibres are most commonly used in the manufacture of board. Synthetic resins or other suitable binders are bonded under heat or pressure, and the strong interparticular bond is created by the binder (Schnieweind 1989:217). Therefore, despite the relative weakness of the bond between newspaper particles, the addition of resins to a newspaper furnish could impart great strength on the resulting board. The fibres are necessary to provide the bulk of the board and to discourage shattering of the resin (J. Vaughan, Designer/Builder, pers. comm.).

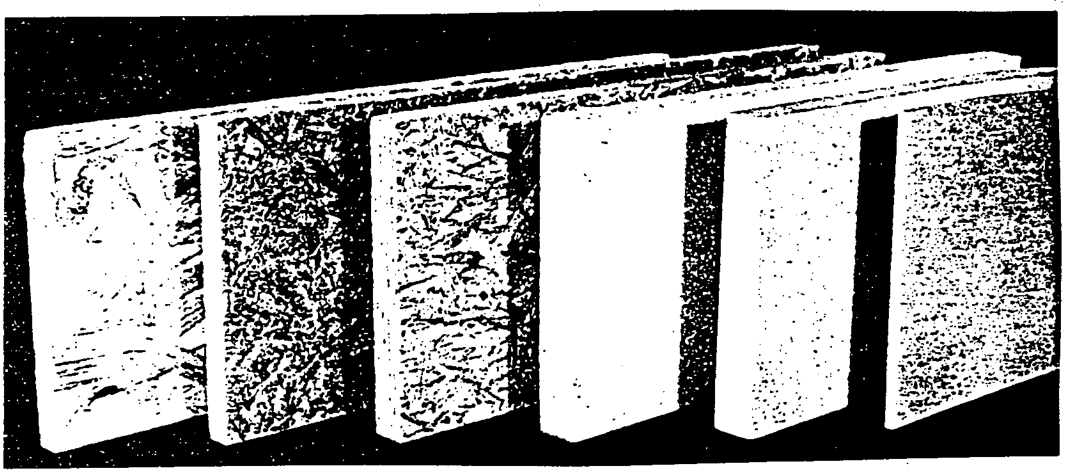
In the production of dry-process fibre board, the material is placed into fibre strength categories, which ultimately determines the end product and the production process used. The furnish is dried to about 4% moisture content, and urea-formaldehyde or phenol-formaldehyde adhesives are added, depending on the purpose of the board. Urea-formaldehyde is usually used for protected interior applications, and phenol-formaldehyde is usually used for structural applications. Wax (0.25-1% by weight) is sometimes added for inhibition of absorption of water in the final product. After blending, set amounts of the mixture are pressed at a temperature of 160°C for urea-bonded and 210°C for phenolic-bonded boards. The finished boards typically range in thickness from less than 25mm to over 300mm, depending on the final product requirements and the type of particle being used (Schnieweind 1989:216).

The principle of fibre board processing is to acknowledge that

> ..."Although the tensile strength of wood fibre is very high, it is generally not utilized to its fullest potential in the structural configuration of a paper sheet or a fibreboard ... The establishment of maximum quality fiber bonds is, therefore, one of the predominant goals of process design" (Schnieweind 1989:131).

An adhesive-bonded product which uses fibres of similar coarseness to paper is currently available in Australia. This medium density fibreboard (see Figure 6) is finer than particle board: it is possible to mould and shape medium density fibreboard with greater success than particleboard made from wood chips (J. Proctor, APPM Particle Board Mill, Wesley Vale, pers. comm.). Tron (1987:26) suggests that fire retardant and insulating materials can be added to the board to provide specific qualities in the finished product. Dry-process fibre board can be used in such applications as laminated counter tops, in furniture, as floor underlay, in cabinets, for interior and exterior cladding, and in mobile home decking. It can be used as a core for materials with wood veneer facades.

Figure 6: Major composition Board manufactured at present: left to right: waferboard, flakeboard, oriented strandboard, industrial particleboard, medium density fibreboard, hardboard (courtesy Washington State University)



Source: Schnieweind (1989:20)

An interesting example of the application of newspaper in dry-process fibreboard is for making coffins. Sullivan Fabrications Pty Ltd, a Sydney-based company, is developing the technology to make coffins from a mixture of mulched newspaper and a polymer binder. The coffins are strong, light and offer a low cost alternative to the materials which have traditionally been used for coffin manufacture. The coffins closely resemble traditional coffins with their 'wood grain' finish (Jeff Allen, Sullivan Fabrications Pty Ltd, pers. comm.).

2.4.2 Non-Adhesive Bonded Fibre Board

There are ways in which to enrich the strength of fibreboard without using adhesives, by strengthening the bonds between the actual paper fibres. One way to do this is to form hydrogen bonds between pulped newspaper particles by wetting then drying the paper, whereby the surface tension of the evaporating water pulls the fibres together (wet-process fibre board). This type of bonding is adequate in boards which do not require great strength. On a specific (dry) strength basis, paper has approximately one-tenth to one-third the strength of wood. "Cellulose fibres and paper ... are therefore remarkably good structural materials for use in low-density applications where stiffness rather than strength is important" (Schnieweind 1989:213).

There are many applications for boards which do not require great strength. A product made from hydrogen bonding of newspaper could be used to replace plywood, which would have important ramifications. Most of the plywood used in Japan is made from tropical rainforest hardwoods. In Japan, 'Philippines mahogany', merantis and luans from South East Asia have been used for four decades as window shuttering and other low grade products (Nectoux 1989:7).

It is feasible that a hydrogen bonded fibre board made from newspaper could be substituted for the plyboard which has been used in the production of Hypertat, a comfortable and energy efficient instant shelter devloped by Jantzen and Bakewell in the United States. This product is a modular building assembled of factory-formed boxes which can be stacked on site to form arches, and the complete structure is assembled by connecting these arches. Fasteners are used to assemble the modules making up the structure, and a building can be set up in very little time by two people, using simple tools (Gilmore 1990:100). There is potential for the use of the Hypertat structure in remote areas for field stations and for disaster relief.

Insulation board can also be produced from processes involving hydrogen bonding. Fire and vermin proofing agents such as borates and boric acid could be applied to these mats, squares or rolls of hydrogen-bonded board. Any thickness of board could be achieved by moulding newspaper and drying it. Unlike the powdery cellulose insulation which is installed in ceilings only, insulation board made from moulded and dried newspaper could be installed in both walls and ceilings.

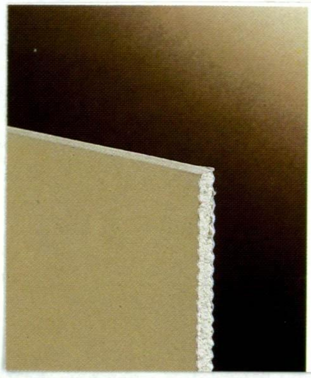
It is feasible that soundboard could be produced from hydrogen bonded newsprint. Soundboard which is produced from newspaper, in mats, squares or in roll form, could be applied to walls, around staircases and under floors. There is potential for the application of soundboard to isolate sound and vibration near hospital operating theatres, and on factory floors and walls.

Currently, there is soundboard available which has been produced from cellular polyurethane; the use of a waste material such as newspaper to produce soundboard would be a viable alternative to the use of such chemicals. Office partitions similar to those made with fibreglass sandwiched between chipboard, with an outer layer of carpet-like material could be produced by sandwiching hydrogen bonded newspaper board between two layers of chipboard (made from newspaper base). The outer layer of carpet-like material can be added as soundproofing material, and the finished product could be comparable to the traditional product.

An example of a board which can be produced from waste paper (without the addition of glues) is gyprock (see Figure 7). Gyprock, produced in Australia by CSR, is made from natural gypsum (calcium sulphate dihydrate) which has been mined and processed, forming a high quality plaster. In a continuous operation, this plaster is mixed with water and other additives to form a slurry. One of the additives in the slurry is waste paper, which helps to reduce the brittleness of the final product. This slurry is encased in paper linerboard, forming plasterboard, and cut to specified sizes.

Generally, long-fibred stocks such as waste kraft paper is used in the production of gyprock, but where waste kraft is too expensive or unobtainable, short-fibred stocks such as newspaper can be used as a substitute. Gyprock is used to dress interior walls and ceilings. It can be cut to size and painted according to individual taste.

Figure 7: An illustration of the range of materials made from Gyprock



Source: Pamphlet distributed by CSR Gyprock

Wall cladding sheets can be produced by the Illawarra Technology Corporation Limited by adding newsprint to cotton wastes. These cladding sheets can be used with formica cladding as kitchen unit tops .

Panel boards made from recycled newspaper and other waste paper products have recently been produced by the Homasote Company in New Jersey, United States. The panels are made by making a slurry out of the paper and water, mixing in additives to improve moisture resistance of the final product, pouring the slurry into moulds, pressing to the required thickness and drying before being cut to size. The panels can be used for sheathing and floor underlayment, and their newest product can be used for interior finish applications. A lightweight jute fabric (burlap) is fixed onto the 1/2 inch thick "Design Wall" panel and laminated. The panels are 4 feet wide and come in lengths of 8, 10 and 12 feet, and are able to be nailed directly over drywall. The panels can be painted any colour with a thinned latex paint (Anon 1991c:66)

2.4.3 Newspaper and Recycled Plastics

Setterholm (1991:82) refers to the use of combinations of recycled plastics such as polypropylene, polyethylene and polyethylene terephthalate, with wood fibres to make composite products such as components for vehicle interiors. The use of resins for the development of a variety of flat and shaped panels for packaging applications and other manufactured products has also been recommended. It is possible that newspaper could be used to replace wood fibres in such composites.

There is the suggestion that the applications for composite paper-plastic products are limited to nonstructural uses, however, with research into the development of stronger products, the development of structural products may be shown in the future (Setterholm 1991:82).

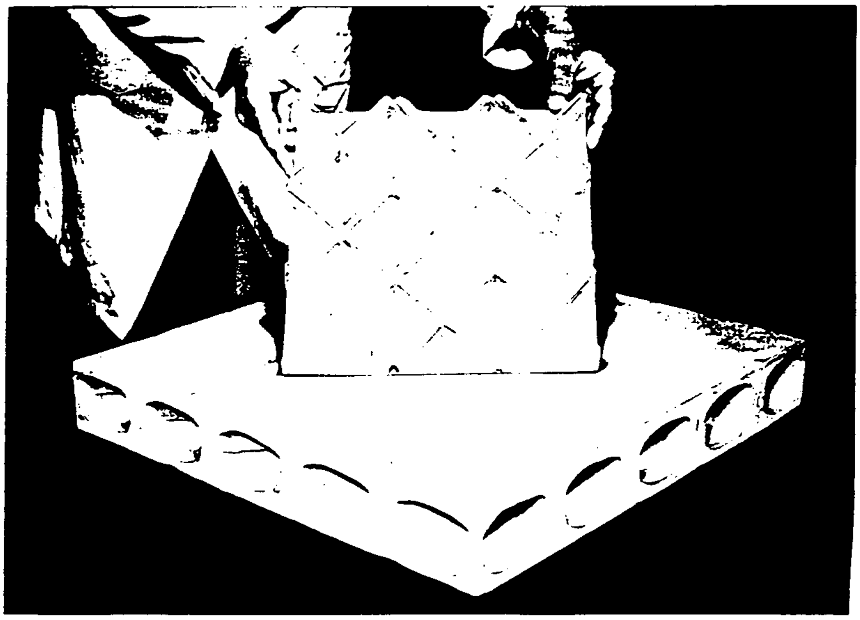
2.4.4 <u>Three-Dimensional Honeycomb Sandwich Panels</u>

A product called FPL Spaceboard has been demonstrated in the United States, and has potential for use in the housing, furniture or industrial market. Recent developments such as the production of Spaceboard have demonstrated properties such as strength and stiffness in waste paper when moulded into a three-dimensional honeycomb (Setterholm 1991:82).

The technology of the Spaceboard process is not new. The incorporation of newspaper into Spaceboard, however, offers a new challenge. Paper honeycomb sandwich panels were being produced in the United States for single storey buildings in the early 1970s, and were quite common. Essentially, in the production of paper honeycomb sandwich panels, paper is formed into a honeycomb structure, and encased in insulating foam and metal or fibre-reinforced structural facings (see Figure 8). Additional facings such as gypsum board are sometimes added to improve the performance of the sandwich. These panels are lightweight, but there is no compromise in strength with the use of paper as an inner material (Reichard 1972:1).

These panels are almost always made with kraft paper made into a honeycomb formation. This paper is relatively inexpensive, but sometimes the honeycomb is made with nylon, polyethylene, fibreglass, reinforced plastics, aluminium, stainless steel and titanium. Usually, a hexagonal configuration is used as the honeycomb in the sandwich panels, whereby phenolic resin is added to impart both wet and dry strength and fungus resistance to the paper. The addition of resin is important to a sandwich panel, as the bond between the facings and the core is of great importance.

Figure 8: Honeycomb sandwich panel



Potential exists for the incorporation of newspaper into a product similar to Spaceboard, which would be assumed to have relatively less strength due to the short fibre length of newspaper compared to kraft paper, yet a satisfactory product could be yielded. This board could be used alone or sandwiched between two weather-resistant boards, and a satisfactorily strong building panel could be produced. The inbuilt air pockets in the honeycomb structure could offer insulating properties. It may be possible to treat the panels to make them vermin and fire proof. Chemical modification can also impart durability and resistance to weathering of the three-dimensional structure if it is not encased in a sandwich panel (Setterholm 1991:82).

A feature of the operation of a prefabricated housing company in Hultsfred, Sweden, is that it uses old newsprint and shavings in the manufacture of load-bearing exterior walls. Modular interior partitions of sandwich construction, using two pieces of 10 millimetre chipboard surrounding a layer of paper filler are being produced.

2.4.5 Building Bricks

Lightweight bricks called 'Bettabricks' have been developed by an organisation in Newcastle, Australia, who have applied for a patent for these bricks. These bricks are made with 75-80% newspaper, blended with particular additives, which are then dried. Bettabricks are one third the weight of a conventional brick, and can be produced for one quarter of the price of conventional bricks. Each brick can be produced for 11-12 cents. Less energy is required for the production of Bettabricks than for conventional bricks, which are fired. Test results are awaited on strength, structural integrity, and as to whether Bettabricks are waterproof and fireproof. Environmental benefits of using Bettabricks include the use of a waste material, rather than the use of materials which have been mined from the earth. Bettabricks are also recyclable (G. Mitchell, Bettabricks, pers. comm.).

Using the technology which has been used to develop Bettabricks, the company is showing interest in producing continuous beams.

One example of a small organisation which has developed the idea of using newspaper in building bricks is the Snowy Mountains Compost Group in New South Wales. This group has developed bricks which could be used in domestic and industrial situations for interior walls. Using combinations of cement, mud, sand and shredded newspaper or office paper, lightweight bricks have been produced, called 'Beautlite Bricks'. The presence of paper confers a lightness to the bricks, without compromising the required strength for a non-loadbearing wall (G. Hambly, Snowy Mountains Compost Group, pers. comm.).

Rudimentary testing has been undertaken on these bricks, which showed that the bricks weathered slowly and that they had a high break strength. More advanced testing will be required to be performed on these bricks for fireproofing, strength, durability, and weatherability. It is hoped that the brick can eventually be modified to enable it to be suitable for outer walls.

There are many benefits of using lightweight bricks in building. For one, the costs involved with the transport of lightweight bricks would be less than the costs involved in transporting conventional bricks. Walls which are made out of lightweight bricks would weigh less than the walls made out of conventional bricks, therefore the foundations would need to be less bulky to support these walls. Fewer raw materials would be needed to produce the foundations to support a lightweight wall, and fewer costs would be involved in building these foundations. It is possible that fewer occupational hazards such as back complaints would occur when using a lighter weight building material, as less heavy lifting would be involved in building.

Romic and Eva Pachucki, of Lower Longley, Tasmania, have developed an exterior brick made from clay and hammermilled newspaper. Four parts of coarsely sifted clay from their property (see Figure 9) are added to one part hammermilled newspaper, obtained from their local cellulose insulation supplier. The bricks they have produced have been used on the exterior of their home, and their interior walls have been rendered with mixtures of clay and hammermilled newspaper. The benefits which they have cited concerning the use of newspaper-based insulation in their bricks include lightness, strength, and they do not slip out of their moulds so easily as clay or mudbricks. The benefit of using newspaper in the mixture for rendering is that the mixture is easy to apply to the walls compared to using clay alone.

Figure 9: Source of Clay from which the Pachucki's Bricks have been made

Figure 10: House of Romic and Eva Pachucki, made with a Component of Newspaper in the Bricks

The Illawarra Technology Corporation Limited, affiliated with the University of Wollongong, has developed bricks for non-load bearing applications, made from cement, newspaper and fly ash. The bricks are made to the size of a large cement brick, and are lighter in weight than a conventional brick. There has been no testing of strength, fireproofing, weatherability of durability on these bricks. Lightweight aggregate pellets have also been developed from fly ash, colliery waste tailings and newspaper. These can be combined with cement and sand to produce lightweight bricks.

Lightweight aggregate pellets are also produced by the Neutralysis process, which involves a combination of household rubbish with liquid waste and clay. These pellets can reduce the weight of a standard concrete block by one third. They can also be used in landscaping and road surfacing. Neutralysis of household waste is being undertaken in Australia by Neutralysis Industries Pty Ltd of Rocklea, Queensland, using a three stage kiln firing process (Templeton 1990:33). The pellets are appropriately hard and porous for use in concrete.

The Illawarra Technology Corporation Limited has developed a refractory brick made from fly ash, newspaper and clay. There is an initial firing of these bricks, whereby the newspaper is burnt, leaving pores in the bricks. Refractory tiles have been developed for use in non load bearing applications such as for furnaces.

The PNEB has funded a project to develop tiles which are made from newspaper waste, carbon waste and recycled tyres. Spaceform, a company supported by the PNEB have developed a lightweight concrete block with a component of newspaper (PNEB 1991c).

2.4.6 Miscellaneous Building Applications

Another development from the United States is that of low cost housing being built from a combination of clay, emulsified asphalt and cardboard or newspaper. Clay is an excellent binder, emulsified asphalt provides the waterproofing, and the cardboard supplements the fibre and the mass, contributing insulating properties and making it lightweight. To make this product called Rub-R-Slate, there is a suggested formula of 13.6 litres of asphalt emulsion, 3.6 kg of shredded paper or cardboard mixed with 45.5 litres of a clay and water combination. The finished product can be sprayed or trowelled onto walls and floors. To make a wall, for example, material such as two layers of chicken wire stuffed with straw or hammermilled paper forms the backup for the Rub-R-Slate. The inner layer of the wall acts as dead-air insulation. The Rub-R-Slate is plastered onto the inside and outside walls of this inner block of wire and fibre.

Spaceform Pty Ltd are investigating the development of a building product which combines recycled newsprint with gypsum to produce an insulation material in conjunction with a roofing/cladding system (PNEB 1991c).

The Norwegian Building Research Institute has developed fibre concrete. A light, hard product with good insulating and sound absorbing qualities has been developed from a combination of macerated waste paper and concrete.

There can be a high strength to density ratio when lightweight componenets are used in building materials, indicating that required strength is not necessarily compromised by the addition of newspaper. When the saving in weight actually means that resources are used in an efficient manner, the costs savings may be apparent. Where newspaper can replace the resources normally used in building, including toxic materials such as polyurethane and fibreglass, metals, and those non-renewable resources such as stone and timber, there are advantages. Less energy is required to manufacture bricks from newspaper than from firing conventional bricks. There is the advantage of harvesting the resources and energy which have initially been invested in the production of newspaper, and avoiding the effects of waste disposal in landfill.

The impacts of the use of adhesives and plastics on the environment must be considered. The use of waste newspaper as a building material, alone or in combination with environmentally benign and durable materials, is to be recommended in preference to the use of newspaper to which industrially and domestically hazardous chemicals have been added.

2.5 Adsorb Hazardous Substances

In recent times in particular, there has been an upsurge in the amount of concern about the use and disposal of hazardous chemicals.

Using the adsorptive capacity of newspaper as a means of 'mopping up' liquid hazardous waste is one way in which to deal with the spillage of hazardous substances. By no means is it the solution to the problems associated with the use of hazardous substances, but it may offer a means of treatment without the addition of other harmful substances, and it may also provide a mechanism for avoiding the disposal of newspaper in landfill.

Adsorption is a physical treatment for the hazardous material which "allows separation of the materials, the hazardous substance and the contaminated medium, without chemically transforming or binding the hazardous substance and without adding chemical reagent"(Unterberg *et al.* 1989:168). Typical adsorbents have small pores which are wetted by the liquid, and the liquid clings to the surface of the material by surface forces and by capillary action.

> "Available information indicates that adsorbents would be of value for treatment of all land spills and of water spills of some organic materials. Use of adsorbents for treatment of water spills will be limited, in most cases, to those substances that are insoluble and float on the water surface " (Unterberg *et al.* 1989:168).

2.5.1 Adsorb Oil Spills in Water

One of the most commonly spilled hazardous substances is oil, and it is often spilled at sea. There is an unprecendented amount of oil which enters the marine environment due to the recovery, transport and use of this commodity. Continuous doses of fuel oil from tanker operation, industrial discharge, and on-shore waste disposal practices contribute to much of the oil pollution at sea, and the devastation from such spills is comparatively high (Moorcroft 1972:108).

Much public attention and research has been focussed on large oil spills, such as the *Exxon Valdez* disaster, where crude oil is spilled, despite the fact that more oil is spilled by continuous dosages (as described above). The disastrous effects of the spillage of oil on the marine environment have been well documented, for example, by Brown (1985) and Continental Shelf Associates (1991).

Ironically, many of the treatments used for the oil spills are just as dangerous for the marine environment as the oil. The disastrous consequences of the use of dispersants in the marine environment has been highlighted after the clean-up operation from the *Torrey Canyon* in 1967. In that situation, "the chemicals (dispersants) were more harmful than the oil itself" (Hoult 1969:35). According to Boesch *et al.*

(1974:88) the safety and toxicity of using materials such as talc are unknown. Problems with the addition of burning agents to oil spills include violent eruptions, diminished combustion (Boesch *et al.* 1974:89) and the impact on the Greenhouse Effect. Heavy oil is virtually impossible to ignite, which is associated with the loss by evaporation of volatile components. Gelling agents are expensive and require time to set. Herding agents are only useful for thin slicks containing small amounts of oil (Boesch *et al.* 1974:90). Polyurethane, a synthetic adsorbent, has some advantage over natural adsorbents as it is recyclable on site, but is not used for major oil spills, and when oil has been adsorbed, it is flammable or toxic (Unterberg 1989:174). Great care must be taken with the use of polurethane, and consideration must be given to the blowing agents which are used to produce polyurethane and their impact on the Greenhouse Effect.

Adsorbent materials, used either with or without a containment barrier, are considered by some to be

> "the only treating agent that can be used safely and effectively at this time. Future developments are expected to make them much more effective, and their potential is a fruitful area for research" (Boesch *et al.* 1974:90).

For many years, cellulose-based materials have been used to adsorb oil and similar organics on the surface of water. Traditional natural organic adsorbents include wood fibre, fibre board, straw, sawdust, bark, peanut hulls and peat moss (Unterberg *et al.* 1989:171).

From an exhaustive survey of literature, both within Australia and beyond, only two references to the use of paper as a method of treating oil spills could be found. One paper relates to the combination of cellulose fibres, cotton linters, or recycled fibre coated with fine particles of a polymer in which oil is soluble (Alexander 1981:3). This polymer contains polybutadiene, polystyrene and emulsifying agents and antioxidants: no reference to the possible toxic effects of the addition of this polymer was made. Combinations of other materials such as Portland cement, Medusa cement, Plaster of Paris and sawdust were also used to assist in settling the mixture. There could be problems associated with cellulosic and other materials sitting on the ocean floor, such as high biological oxygen demand upon degradation by micro-organisms, and alteration to the substrate on which shellfish attach. The deposition of oil on the ocean floor could induce devastating ecological impacts on marine benthos. Eventually, the oil floats to the surface (Alexander 1981:1). The impact of spilt oil on marine organisms may be delayed, but not avoided.

Other research pertaining to the use of paper for treatment of oil spills was undertaken by the U.S. Army Natick Laboratory in 1973. Paper fibres 0.01-0.05 mm in diameter and 0.75-2.00 mm long absorbed approximately 28 times their weight of oil spilt on an aqueous surface. If the paper fragment size was much larger (1mm diameter and .23 cm long) or smaller (less than 0.05mm) the paper only absorbed twice or the same amount of oil as its weight (Kercher and Webb 1988:45). From the literature it was impossible to determine whether newspaper was used in this trial.

According to Unterberg *et al.* (1989:171) the "Removal of oil-soaked or other organic-soaked natural adsorbent is imperative for effective spill treatment". By experimentation, it has been found that application of hammermilled newspaper does not encourage the oil to sink, which has benefits for the marine environment. Comparatively small quantities of hammermilled newspaper have the capacity to effectively adsorb a large percentage of the oil spilled in water, causing the oil to clump, making it easy to collect. With the efficient use of booms, the oil/newspaper combination can be collected.

2.5.1.1 Experimentation to Determine the Success of Treatment of Oil Spilt on Water with Hammermilled Newspaper

By laboratory experimentation as part of the research for this thesis, it has been found that finely hammermilled newspaper, of the grade used for cellulose insulation, can be used to successfully adsorb oil on the surface of water.

In the experiment the effectiveness of hammermilled newspaper in adsorbing Castrol GTX2 20W/50 engine oil on the surface of fresh water was assessed. It is, therefore, only an initial appraisal of the effectiveness of newspaper in adsorbing oil: under other conditions, whereby, for example, salt water is used, the effectiveness may differ.

From an initial visual trial, newspaper which had been shredded into 5mm wide strips was not as effective at soaking up oil on the surface of water in a 3000 mL beaker as hammermilled newspaper. When shredded newspaper was added to the beaker, pockets of oil were unadsorbed while much of the newspaper absorbed water. When hammermilled newspaper was added to the beaker, the oil attached to the paper particles, and the oil and paper formed a sticky mat. There were no free pockets of oil, and the newspaper appeared to preferentially adhere the oil and not absorb water.

It was observed that the optimal amount of newspaper to add to the oil in order for the oil to adsorb to the paper on the surface of the water, and without allowing any of the paper to absorb water and sink, was 10% of the weight of the oil i.e. one part newspaper to ten parts oil (by weight).

Visual inspection of the oil/water mix suggested that almost all of the oil could be recovered by adsorbing it on hammermilled newspaper. In an affort to quantify this, known weights of oil were added to water, a known weight of hammermilled newspaper was added, then the paper plus adsorbed oil were carefully removed, dried and weighed to estimate the proportion of oil recovered.

As drying involved heating the oil/paper mix to 100°C there was a possibility that some of the oil might have evaporated. This was tested in preliminary trials. Mixtures of known weights of oil, water and paper, oil and paper, and paper and water were made up into petri dishes, and each were dried for 24 and 48 hours respectively in an oven at 100°C. The amount of newspaper added to the oil was in the ratio of 1 part paper to ten parts oil. The results of evaporation tests from each of these trials is summarised in Experimental Results Table X.

Table X: Percentage Weight Loss from Oil, Water and Newspaper after drying at 100°C.

Evaporation	Oil, Water and Newspaper	Oil and Newspaper	Water and Newspaper
Dried for 24hrs at 100°C	0.970%	0.695%	100.24%
Dried for 48 hrs at 100°C	1.165%	0.810%	100.31%

These trials showed that very little oil evaporates when the oil/paper/water mix is heated to 100°C for 24 hours. The results also show that the water has evaporated in that time. This means that this method of estimating recovery rates of oil should give a reasonably accurate result, as oil evaporation due to heating is neglegibe.

It was then possible to undertake the experiments to establish the absorptive capacity of the hammermilled newspaper. To 2000 mL of tap water in a 3000 mL beaker, 160 g of Castrol GTX2 20W/50 oil was added (see figure 11). To this water/oil mixture, 16.024 g of hammermilled newspaper was added (see figure 12). The mixture was agitated to allow contact between the oil and newspaper, forming a sticky mat (see figure 13). This mat was scooped up by a tea strainer onto a petri dish, dried and weighed.

Results of the effectiveness of the paper in adsorbing oil are shown in Experimental Results Table Y.

Table Y: Results of Experimentation to Determine the Success of Treating Oil spilt on Tap Water with Hammermilled Newspaper.

Initial Weight of Oil	160.000g
Initial Weight of Newspaper	160.024g
Weight of Oil & Paper after drying	158.369g
Weight of Oil lost from Evaporation after 24 hours drying at 0.97% evaporation rate	1.536g
Total Amount of Oil Retrieved after Treatment with Newspaper	159.905g
Retrieval Rate of Oil by Treatment with Newspaper	99.94%

(Scooping the paper/oil mixture by a strainer was the closest measure available to simulate a 'clean-up' operation at sea. The author recognises that this procedure may pose a bias in the amount of material collected i.e. the treatment of oil spilt at sea may not be as successful as the treatment of oil spilt in the laboratory. This experiment is purely meant to show the success of the addition of the optimum amount of paper which will stick to the oil).

Figure 11: Layer of oil added to the Beaker in Experimentation

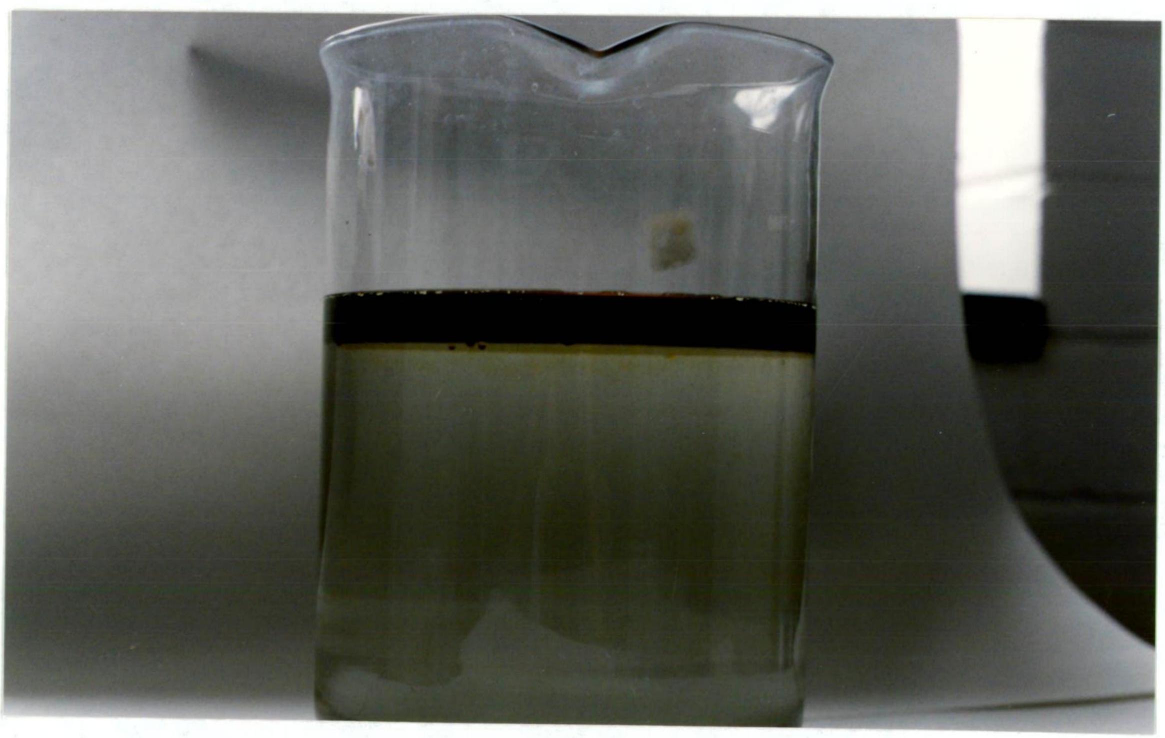


Figure 12: Hammermilled Newspaper when added to oil and water

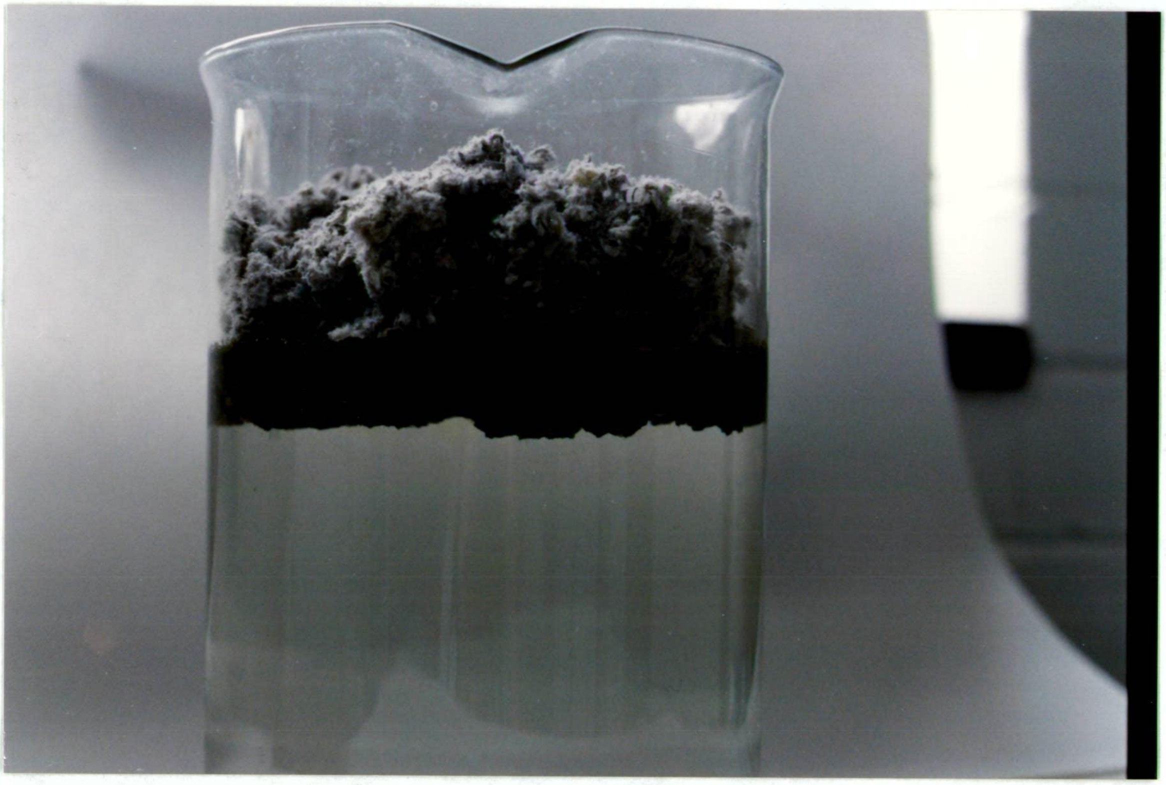
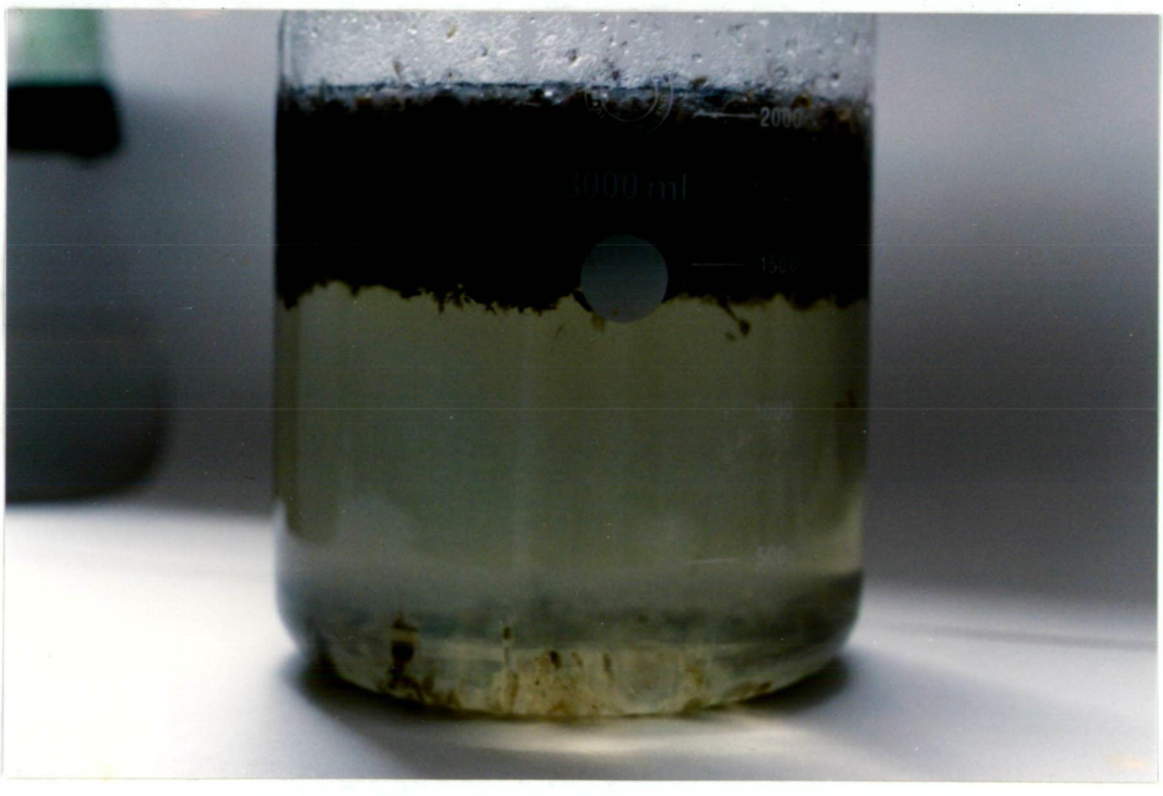


Figure 13: Hammermilled Newspaper after the adsorbing oil, showing the formation of a sticky mat



After scooping the oil/paper mixture off the top of the water with the tea strainer, there appeared to be very little oil or paper left in the beaker (see figure 14). This pictorial evidence gives testimony to the success of the newspaper in adhering to the oil, hence, when attempts were made to pick up the mixture with the tea strainer, it was sticky enough to ensure that almost all of the oil was picked up.

Figure 14: Newspaper/Oil residue after treatment

2.5.1.2 Practical Application of Hammermilled Newspaper to Floating Oil

In a practical situation, the amount of oil spilled must be approximated in order to estimate the amount of paper to add to the oil. This may be possible if the size of the container in which the oil was being carried is able to be estimated. At the site of spilled oil, this fine paper 'dust' could be blown onto the oil from a vessel. As oil which has had contact with hammermilled newspaper is able to float, it is possible that the newspaper which has been used to adsorb oil on the surface of the water could be gathered by mechanical skimmers. The use of adsorbents such as newspaper could also be combined with pollution control barriers and an oil pumping system to treat oil spills in water.

Visually, the hammermilled newspaper appears to cause the oil to form into clumps, which would make the oil easier to collect than oil as a sheen on the water. This oil/paper combination is very sticky, and it is assumed that the use of hammermilled paper and oil from water will be compatible with the use of booms and skimmers.

Skimmers are vessels which are used to remove liquids floating on the surface of water (Unterberg *et al.* 1989:164). Most skimmers have been designed for oil collection: if oil can be clumped it may be easier to collect. It is essential that when using skimmers with flammable spills, electrical equipment and motors are explosion-proof. There are four classes of skimmers: moving plane skimmers, belt skimmers, weir skimmers, and suction head skimmers. Weir skimmers and suction head skimmers remove both oil and water (Unterberg *et al.* 1989:164). Moving plane skimmers have a flat pickup element which is dipped into the slick: the element is withdrawn and the adhering substance, oil, can be wiped off into a reservoir on the vessel. Belt skimmers employ an adsorbent belt to lift the substance out of the water and into a reservoir. Weir skimmers consist of a collection reservoir, the lip of which is below the surface of the oil: these skimmers are unsuitable for collection of adsorbent materials as they usually have a screen to keep out debris (Unterberg *et al.* 1989:164). Suction head skimmers are also unsuitable for the collection of oil and paper as they rely on suction of the materials through hoses after the entry of material into the reservoir. If the debris screens are removed from weir skimmers and suction head skimmers, there may be potential to use these skimmers to treat oil spills which have been treated with hammermilled paper.

Booms could also be used to deal with oil spills treated with hammermilled paper. Surface booms are placed downstream or downwind from a spill in order to catch and hold oil. They may be used to totally encircle a spill. Boats can also be used to drag the contained oil away from the site of spillage for treatment (Unterberg *et al.* 1989:145).

Pumping is applicable to relatively insoluble, floating spills. It has been suggested that, if pumps can be deployed rapidly, undissolved floating material can also be removed (Unterberg *et al.* 1989:165). Pumping may be appropriate for the collection of oil treated with hammermilled newspaper.

The question may arise as to the effectiveness of the treatment of oil spills with hammermilled newspaper in the 'real situation'. One author has suggested that it may be that the effectiveness of adsorbents such as newspaper are not diminished by the adverse conditions at sea. "In fact, better results can sometimes be obtained in the presence of waves than in calm water" (Boesch *et al.* 1974:90). This may be due to the enhanced contact which the oil has with the adsorbent material due to the wave action. Unterberg *et al.* (1989:172) suggest that the application of particulate adsorbents is not to be recommended during windy conditions, or when water conditions are flowing, choppy or agitated. "These materials are recommended for use on land spills and on insoluble floating spills in relatively undisturbed water" (Unterberg *et al.* 1989:172). Experimentation either at sea or in simulated wave conditions in a wave tank is recommended to test the effectiveness of the treatment *in situ.*

The effectiveness of using newspaper to treat oil spills in the natural environment is yet to be trialled, but there is the possibility that the repercussions for this treatment of oil by newspaper are immense, given the sheer volumes of oil spilled at sea and in quiet waterways every year. It is possible that research could be undertaken into the attachment of oil-degrading micro-organisms to the surface of hammermilled newspaper.

Using newspaper as a method for treating oil spills not only has the potential to assist in the collection of spilled oil from the marine environment, it re-directs newspaper from disposal in landfill. Hammermilled newspaper is also inexpensive, readily accessible and assumed to be non-toxic to the marine environment if it is collected quickly. There is the potential for the development of fuel bricks from the combination of oil and newspaper collected.

2.5.2 Adsorb Hazardous Materials on Land

One organisation in Victoria has spent four years developing a treatment for hazardous waste spills with the use of waste newspaper. Baramil Holdings has developed a rapidly absorbing pellet for use on oil spills and for other liquid spills. There are applications for these pellets in garages, factories and even the domestic market (Baramil Holdings Representative, pers. comm.).

2.6 Dewatering Wastes

Finely pulped waste newspaper can be used to filter industrial and food wastes from which water does not easily separate. The waste is passed through this pulped paper, and the waste can become separated from much of the water as the water seeps through the finely ground paper. Often the proportion of water in such wastes is high. If water can be removed from this waste, there will be a reduction in the weight and volume of these wastes, hence a reduction in the cost of transport and disposal of such wastes. Opportunity may exist for the reprocessing of these dewatered wastes, consequently, sending some wastes to settling ponds may be avoided.

The Illawarra Technology Corporation of Wollongong have used waste newspaper as a filtering aid for colliery waste, containing clay and coal. Water levels of the waste were reduced from between 70-80% to below 35%. With less water in it, this waste occupied less area for disposal. There were more options for disposal, depending on the quality of the material remaining. The material was high in clay content, and with the addition of fly ash, could be used for spraying onto mine roadway walls and roofs. If a mine is subject to an influx of water, the addition of a few percent of Portland Cement will make a mixture which is resistant to water degradation.

The Illawarra Technology Corporation are in the experimental stages of making a lightweight brick from clay-containing wastes with up to 50% fine coal wastes and 15% newspaper. These bricks have been fired at very high temperatures, the paper and coal particles acting as internal fuels. These bricks have not been tested for strength and structural integrity, and it is unknown as to whether these bricks will be suitable for the marketplace.

Often food and industrial wastes containing water are simply stockpiled in large dams or settling ponds, which require a lot of space and it takes time for the materials to settle out. It is feasible that contamination of ground water may occur from settling ponds, depending on the waste, the permeability of the soil and the ground water patterns. Where there is wind and rain, the wastes are being continually unsettled in the ponds. There may be problems with unsightliness and odour from settling ponds. It is also important to account for the costs involved with disposal of non-dewatered wastes, which are high due to the weight and volume of such wastes.

There are many opportunities to treat water-logged wastes with newspaper as a filtration agent. The use of waste newsprint as a dewatering agent is a way to use waste newspaper, although, depending on the nature of the waste filtered by the paper, there may be disposal problems with the paper. There is the possibility of incorporating newspaper soaked with dairy and colliery wastes into fuel bricks, although the potential for causing atmospheric pollution from burning such bricks must be examined.

2.7 Miscellaneous Applications for Newspaper

There is great diversity in the products which can be made from newspaper, some of which have not been previously detailed in Chapter 2.

Screens, light shades and greeting cards can be made from newspaper. One company in the U.K. produce Speckletone paper, a specialty stationery product made from newspaper which has been repulped and flattened, without de-inking. There is also an Australian company called Corban and Blair producing specialty stationery from repulped newspaper. The stationery kit is presented in a decorative box, made from pulped newspaper, and includes a pencil container, also made from repulped newspaper (T. Wilkins, News Limited, pers. comm.).

It is possible that strong office folders could be made from repulped and dried newsprint. Office folders made from 100% recycled paper board are made in Canada and distributed in Australia by Datafile WrightLine in Sydney (Anon 1990b:35).

In Queensland, shredded newspapers are being made into sunshades for young pineapples. Bananas can be wrapped in newspaper and placed in the refrigerator in order to keep them fresh for longer (T. Wilkins, News Limited, pers. comm.).

Baramil Holdings Pty Ltd in Victoria produce a newspaper pellet which is used a 'kitty litter'. The product is absorbent and can be used to control odours. There are no additives to the pellets. The product lasts twice as long as conventional kitty litter, approximately one week (Baramil Holdings Representative, pers. comm.).

Pratt Industries have been making sleeping bags from waste newsprint. These disposable sleeping bags would be of benefit in emergencies or in natural disaster relief situations where emergency bedding is required.

Kercher and Webb (1983:46) report that low grade waste paper has been used for the manufacture of incontinence pads.

Mechanical compaction has been used for extensible paper applications such as sacks for agricultural and chemical products which require stretch and energy absorption. "Clupack" extensible paper was developed in 1958 from an invention by Sanford Cluett, who also developed the "Sanforized" process for textiles. Stretch paper products from newspaper could be developed in the future.

Shredded newspaper can also be used as a packaging material.

2.8 Energy Source

When there is a perceived lack of options for recycling or reprocessing newspaper, the idea of using newspaper in combination with other wastes as a form of energy can be presented. With concern about the use of fossil fuel energy and the waste disposed in landfill, it may be appropriate to use waste as a form of energy.

Much energy can be derived from newspaper, and the use of this energy is preferential to dumping this resource into landfill. It has been estimated that the 3.4 million tonnes per annum of potentially recoverable paper in the United Kingdom has the fuel potential equivalent of 2.0 million tonnes per annum of coal from the United Kingdom (Tron 1987:26). There are advantages of using waste newspaper as a source of fuel, replacing some of the conventional non-renewable sources of energy such as coal and oil.

2.8.1 Municipal Refuse as a Large Scale Energy Source

Increasingly, municipal waste is being investigated as a source of energy. Since newspaper is a reasonably large component of municipal waste, having a calorific value of approximately 17MJ/kg, the combustion of this paper may contribute to the value of municipal waste as an energy source (Tron 1987:26). Generation of energy from household paper, mixed plastic and combustible industrial materials, which are often considered non-recyclable, is common overseas. In Japan, 25% of all electricity is generated from waste - in Sweden, 50% of all electricity is generated from waste (Kerr 1990:41). In some areas space for landfill is scarce and options for waste disposal are limited.

There are various technologies which can be used to generate energy from municipal waste. Since newspaper is a component of municipal waste, it is relevant to discuss the ways in which municipal waste can be used as a component of fuel. Some of the ways of deriving energy from waste can be described.

1. Mass Incineration is a process in which mostly untreated waste is burnt in a boiler, generating steam. One tonne of domestic rubbish can provide enough steam to produce up to 400 kWh of electricity (WARMER 1990a).
2. Fuel Enhancement is a method of generating energy by burning Refuse Derived Fuel (RDF), which is municipal waste from which inert materials such as glass and metals have been removed. Refining waste may produce a fuel which has 45-60% of the calorific value of industrial coal (WARMER 1990a). RDF pellets are usually the size of wine bottle corks, are clean to handle, have no smell and are stable in storage.
3. Pyrolysis is a method of heating the waste and liberating a gas which can be used directly or condensed to yeild a combustible oil.
4. Acid Hydrolysis converts the cellulose in newspaper into ethanol.
5. Anaerobic Digestion is a process of digestion of organic waste in tanks, producing methane gas (Hydro-Electric Commission 1988: Appendix 1).

The energy which has been generated from waste can be applied in various ways. Practical applications of the technologies of mass incineration and fuel enhancement can be shown from around the world. In Western Australia, one council heats its pool using the energy generated from waste (Kerr 1990:41). The Grinda Waste Treatment Facility in Norway produces fuel briquettes from the plastics and paper fraction of the local municipal waste supply (The Alliance for Beverage Cartons and the Environment, undated). Salimando (1990:76) reports on the idea that RDF can be made into a feedstock for the production of ethanol or gas without burning.

2.8.1.1 Mass Incineration

The Hydro-Electric Commission (1988:Appendix 2) alludes to three processes of mass incineration of municipal waste. The grate system is the most common, whereby the movement of a grate rolls and mixes the refuse, exposing new material to the high temperatures in the incinerator. The action of the grate eventually compacts the material. The rotary kiln and the fluid bed processes can also be used. Boilers are arranged above the combustion chamber to allow the transfer of heat from hot gases to a working fluid. The way in which the boiler is designed is important to mass incineration plants as it must allow the gases sufficient residence time to prevent the formation of toxic compounds such as dioxins (Hydro-Electric Commission 1988:Appendix 2).

A major benefit of mass incineration technology is that there is a volume reduction of up to 90% of the original weight of the waste, and a weight reduction of 60-70%. If the process is properly conducted, the residual ash is "virtually sterile" and can be landfilled (WARMER 1990a).

Great care must be taken in mass incineration of waste. There is a danger of liberating toxins from the improper combustion of plastics. Sources of heavy metals must be screened before their incineration, otherwise there may be heavy metals in the residues from incineration. Water used to quench the ash from incineration must be disposed of carefully (Hydro-Electric Commission 1988: Appendix 3).

It would be ideal to completely isolate hazardous chemicals from the mass incineration of municipal waste to avoid contamination of ash and the possibility of hazardous emissions. It must be ensured that boiler design is appropriate for the prevention of hazardous emissions. Constant and rigorous monitoring of emissions and ash quality would be necessary for environmental safety.

2.8.1.2 Refuse Derived Fuel

Newspaper can be incorporated into Refuse Derived Fuels. Essentially, RDF pellets are produced by screening, shredding and magnetically separating material, and are graded according to the level at which impurities are removed. High grades of RDF, such as RDF 2 or RDF 3 can be burnt in suspension as a supplement to coal in industrial burners (Hydro-Electric Commission 1988:Appendix 2). RDF pellets can also be used in power stations, boilers or cement kilns (WARMER

1990a). It is desirable to specify the specific energy, the ash content, moisture content and the level of impurities, hence indicate the purpose for the fuel.

In doing so, it may be possible to compare the energy derived from RDF to that derived from coal. It is important to note that the energy derived from RDF can be variable, and the energy from coal varies from place to place. In Britain, RDF2 and RDF3 pellets produce 45% to 60% less heat than British coal when they burn. British RDF produces only 0.3% sulphur compared to 1.5% of sulphur emitted when British coal burns (WARMER 1990a). It could be appropriate to substitute a certain amount of RDF for non-renewable fossil fuels used for generating heat and electricity. Testing would be required to analyse the Greenhouse gas emissions from burning RDF, and whether these emissions were favorable to those produced by the combustion of fossil fuels.

The combustion of RDF has similar environmental impacts to that of mass incineration. There is also land pollution resulting from disposal of the waste from the manufacturing process, and air pollution from dust produced in manufacture (Hydro-Electric Commission 1988: Appendix 3).

2.8.1.3 Pyrolysis

Pyrolysis as a means of waste disposal has, in the past, failed due to technical and economic problems. Since the process can provide a way of dealing with toxic metals and organic pollutants at very high temperatures, it warrants further trial and investigation. Manufacturers were close to implementing a pilot plant for the pyrolysis process in Germany in 1988 (Hydro-Electric Commission 1988:Appendix 2).

In pyrolysis, emission levels are well below the regulatory limit for air pollutants in Germany. Wastewater is acidic and low in heavy metals and can be treated by a wastewater plant. Since heavy metals are not oxidised by this process, they are non-toxic, hence land pollution from this process is minimal.

2.8.1.4 Acid Hydrolysis

Techniques of hydrolysing cellulose-containing materials have been investigated widely. The acid hydrolysis method hinges on the breakdown of cellulose and water in the presence of acid and heat to form glucose, and the production of ethanol from this glucose, in the presence of yeast (Porteous 1977:95). Newspaper is very high in cellulose, and since there is much newspaper waste, it could provide a large source of cellulose for ethanol production. The ethanol which is produced can be used as a fuel.

In New Jersey, U.S., there are two companies currently pursuing commercial plants to produce wastepaper into ethanol by acid hydrolysis. The process which the companies will use was initially designed to turn yard waste and wood chips into ethanol, but experimentation showed that it was also possible to convert low-grade waste paper into ethanol. A by-product of the process, which is high in starches and sugars, can be used for animal feed (Salimando 1990:78). The advantage of a plant such as this is its flexibility: if an unexpected shortage of waste paper was to occur, the plant could use yard waste and wood chips as a source for ethanol production. One plant, expected to use the acid hydrolysis method in West Virginia, claims that 80% of the municipal refuse will be used to produce ethanol, producing as much as 113.7 litres of alcohol from 907 kg of waste (Salimando 1990:78).

2.8.1.5 Anaerobic Digestion

Large scale anaerobic digestion of municipal waste is being pursued in Florida in the U.S., whereby 17,000 cubic metres of methane and carbon dioxide gas per day is being produced from 68 tonnes/day of waste. Tanks with a diameter of 15 metres, with a capacity of 1270 cubic metres are used, each being equipped with a 90kW motor (Hydro-Electric Commission 1988:Appendix 2).

2.8.2 Industrial Fuel Source

As well as using RDF pellets from municipal wastes in furnaces, it may be possible to use newspaper (either with or without combination with industrial wastes) as a source of fuel in industrial boilers, kilns or furnaces.

The combination of newspaper with other waste materials could elevate the calorific value of the paper above 17MJ/kg. For example, plastics have a calorific value of 37 MJ/kg (WARMER 1991a). Potential exists for the combustion of such combinations of waste materials in commercial furnaces, replacing the use of fossil fuels such as coal and oil.

2.8.3 Domestic Fuel Source

2.8.3.1 Igniting Domestic Fires

It is common for newspaper to be used in the home to assist in the ignition of wood, which is used as a domestic heat source. It is often convenient to use newspaper to start the open fire or to ignite wood in the slow combustion heater or stove. Anecdotal information has implied that the amount of newspaper a household can provide for council recycling schemes is influenced by whether or not the household has a wood stove.

2.8.3.2 Source of Heat for Cooking

Newspaper is used as a fuel source in the "Energy Saving Miracle Barbeque", which is a lightweight aluminium barbeque. It is claimed that this barbeque uses only four sheets of newspaper to cook meat in four minutes. There may be potential to use newspaper not only for fire-starting but for domestic cooking.

2.8.3.3 Newspaper 'Logs'

The use of firewood for domestic heating has been increasing for the past 10 years with an increase in the amount of homes fuelled by woodheaters. For example, more than 40% of homes in Tasmania are currently fuelled by woodheaters. The popularity of this form of energy source is increasing due to increases in the price for other energy sources, as a result of improved design in woodheaters, and due to a desire for independence of energy supply (Todd and Singline 1989:i). With the increased popularity of woodheaters, there is an concomitant increase in the demand for fuel for these heaters. This has placed pressures on the native forests, farms and roadside ecosystems to supply homes with firewood (Todd and Singline 1989:20).

Newspaper can be used to produce 'fuel logs', which have the potential to be used in combustion heaters. Newspaper can be rolled, tied with wool or twine, and soaked with soapy water for at least 12 hours. They can be placed in a wood-shed and dried out for up to two weeks, and when they have dried it has been reported that they burn "just like a log of dry wood" (Australian Broadcasting Commission, unpublished).

Many years ago, "K-Tel" sold an apparatus which enabled domestic production of 'logs' from sodden newsprint. These "Combustabricks" were made by packing wet newspaper into the brick-shaped mould, and compressing by a clamp, then drying. Opportunity exists for the production of such 'logs' in the domestic scene, or on a larger scale.

Goldberg (1989:38) indicates that composite logs are being produced in the U.S., containing paraffin, sawdust and finely hammermilled newspaper. A water resistant briquette is also being produced from waste paper, a binder and coal in the U.S. (Hackett and Harris 1988). Laboratory tests, pilot scale briquetting and pulverising tests have been completed on the latter briquettes, and these briquettes were found to have similar properties to coal. In Wollongong, the Illawarra Technology Corporation Limited have developed a fuel briquette by combining newspaper with sawdust and troublesome dairy wastes. This group has received funding from the second round of PNEB funding for research into the development of a briquette from newsprint, sawdust, cotton wastes or fat and protein based food sludges (PNEB 1991c).

Good Samaritan Industries in Western Australia have received a grant from the PNEB to meet the design costs on a machine to manufacture newsprint logs. The production of newsprint logs by prisoners is being investigated by the Department of Community Services in Hobart, Tasmania.

There is some doubt as to whether these logs can be used as the sole source of energy in a wood fire. They could be used to help ignite the fire, but it is possible that they do not result in the production of hot-burning coals like those which result from wood. Further investigation is necessary. If they can be used to replace at least some of the logs in the fire, they have served the purpose of representing one way to alleviate the problems of disposal of newspaper.

It would also be necessary to test the emissions and particulates from the burning of these newspaper logs to determine the environmental effects of the use of this paper, and a comparison would need to be made between the safety of the use of newspaper fuel compared to that of wood. There is concern about the health effects from the particulate emissions from woodsmoke in many cities, so an alternative such as newspaper logs would need to be tested for emissions. If necessary, smokeless fuels can be produced in areas which are less likely to suffer from pollution from wood smoke. Smokeless beads could be produced by charring mixtures of paper and sawdust, and sold in areas which are normally prone to pollution problems from combustion of woodsmoke.

It must be acknowledged that burning refuse as a source of energy is not a panacaea; prime consideration should be given to conservation of resources, reducing the amount of waste produced and recycling. However, when it is impossible to reduce the amount of waste produced by these measures, and consideration is given to energy prices, the Greenhouse effect and waste disposal, the practice of burning waste to generate power may be beneficial to the environment as an alternative to landfilling newspaper.

> "Planning waste combustion systems, either incineration with heat recovery or via the production of waste derived fuel requires careful consideration of the quantities, components and alternative routes for disposal or re-use of the wastes involved so that cost effective ways of recycling the fibre or use as fuel can be highlighted."(Tron 1987:26).

The objective of this thesis, so far, has been to assess the reasons for reducing the consumption of, re-using, reprocessing and recycling waste newspaper. There can be little justification for the current propensity of our society to dump newspaper in landfill, particularly when newspaper can be used as a resource for the manufacture of new items. Several options for reprocessing newsprint are offered in Chapter 2. Many of these options were found to be implemented with success in overseas countries, and there is the possibility of implementing such ideas in Australia in order to establish markets for used newspaper.

CHAPTER 3

ASSESSMENT OF THE ECONOMIC ISSUES AND THE FEASIBILITY OF OPTIONS FOR REPROCESSING NEWSPAPER IN TASMANIA, AND THE POTENTIAL FOR ENCOURAGING EXISTING NEWSPAPER REPROCESSING INDUSTRIES IN TASMANIA

The objective of this chapter is to highlight the economic potential for implementation of options for reprocessing newspaper, with particular reference to Tasmania as a case study. Tasmania is an island state with a relatively small and dispersed population. It is important to establish reprocessing in Tasmania as it is expensive to freight newspaper to mainland Australia, there are few reprocessing facilities currently in existence, and, consequently, much newspaper is being landfilled. The environmental costs of transporting newspaper long distances may be high. There is potential to employ people in reprocessing industries, which may be particularly desirable in times of high unemployment.

It is essential for any industry to analyse the costs of manufacturing, and to make decisions based upon the likelihood of the manufactured items to perform in the marketplace. In the same way, it is vital that the costs of both newspaper collection schemes and the manufacture of reprocessed items are analysed in order to make decisions about the likelihood of the venture to make a profit, or simply survive, in the commercial world. It is ideal if these reprocessing industries invoke a consistent demand for newspaper; realistically, they can only consistently demand newspaper when they sell the product which has been made from newspaper. To survive in the commercial world, manufacturers must ensure that the product has a market. Analysing the market potential is an essential component in the analysis of the suitability of manufacture of the product.

Recommendations concerning the most promising options for reprocessing newspaper in the current economic climate are made, based on economic viability. If a preliminary assessment of the economic viability of an option showed promise, a more detailed examination followed. This has meant that some options received only cursory attention, but time constraints on this thesis meant that this was inevitable. More detailed study may have shown that some of the options which initially seemed to show no promise were actually promising. Some of the options which seemed to show promise may have appeared to have been given a disproportionate amount of attention, but comprehensive study on viability was required once an investigation was initiated.

Reference is made to the options for reprocessing newspaper which may not be economically viable at the moment, but may have potential commercial viability with assistance from the community, industry and the government. The potential role of community, industry and governmental intervention in alleviating some of the current obstacles which may be encountered with the establishment of reprocessing industries in Australia will be addressed in Chapter 4. The importance of this assistance will be acknowledged with reference to the environmental and societal benefits to be gained from reprocessing a secondary resource as valuable as newspaper.

The measure of the potential for success of the reprocessing ventures was based on estimations of the current costs involved with the reprocessing venture and the expected performance of the reprocessed item in the marketplace, based on information gleaned from current manufacturers. Information regarding the constituents of products and the 'marketability' of potential products was often restricted due to confidentiality of those in industry. In many cases, information did not exist.

It must be emphasised that the economic feasibility of options for reprocessing newspaper was reviewed in terms of providing for a relatively large 'economy of scale' - the whole of Tasmania. It may be that a proposed small scale venture is viable if it caters for a smaller market.

3.1 The Amount of Newspaper Reprocessing Currently Undertaken in Tasmania

To investigate the possibility of implementing newspaper reprocessing schemes in Tasmania, it is important to recognise the extent and type of reprocessing ventures which already exist in Tasmania. This gives an indication of the market for certain products. Basic market research techniques involve researching the existing businesses, and seeing whether these businesses fulfil the demand for the product or service. If a business is profitable, it may be that there is potential for either expansion of this business or the establishment of a new business to help meet a foreseeable demand for the product. Where there is no business to meet a foreseeable demand for a product, an investigation into the potential market for a new product could be undertaken.

A snapshot of the newspaper reprocessing occurring in Tasmania in 1991 is provided. Figures are derived from telephone conversations with representatives from these organisations during 1991. These organisations include Southern Recyclers in Hobart, who organise the collection of approximately 800-1000 tonnes of newsprint per annum, which they send to Melbourne. Statewide Paper Collectors also transport approximately 300 tonnes of newsprint to Melbourne. It was suggested that most of the paper sent to Melbourne is used in the manufacture of cardboard. Approximately 387 tonnes of the Tasmanian paper may be exported to overseas countries, according to the Weekly ONP Market Status Report of News Limited (see Table 1). Approximately 300 tonnes of newspaper per annum is used to produce 'Charlie Fluf' Insulation in Tasmania: this paper is purchased from Statewide Paper Collectors. Spraygreen uses approximately 50-60 tonnes of newspaper per annum in the application of hydromulch, which is also purchased from Statewide Paper Collectors. About 1 tonne of newspaper per year is sold as Mache Fluff, which is used in schools as an art material.

From these estimations, the rate of reprocessing in Tasmania can be approximated. Of the 9,000 tonnes of newspaper consumed in Tasmania, approximately 1461 tonnes, or 16%, of newspaper is reprocessed or exported. News Limited established that the Tasmanian 'recycling rate' of newspaper (the amount reprocessed and exported) is 15% (see Table 1). The recycling rate for Tasmania is much lower than the national recycling rate of 37%.

It may be relevant to appreciate that the consumption of newspaper in Tasmania is lower than the consumption of newspaper in mainland Australia. With a newspaper consumption of 9,000 tonnes per annum and a current population of approximately 457,000 (ABS representative, pers. comm.), the average Tasmanian consumes approximately 20 kg of newspaper per annum, compared to the national consumption of 32 kg per annum per person (see section 1.4). Despite the fact that less newspaper is consumed in Tasmania than on the mainland, there is still a case for increasing the amount of reprocessing. The low 'recycling rate' is testimony to the fact that much of Tasmania's newspaper is being wasted.

To establish a newspaper reprocessing operation, the proponents must be able to pay the capital costs of establishment, and to fund the costs of collecting newspaper and other operating costs. It is vital to consider the expected demand for the product in an assessment of the likely economic viability. Marketing the product is an important part of establishing a reprocessing venture.

3.2 Costs Involved with Collecting Newspaper

Newspaper which is available for reprocessing includes post-consumer newspapers, newspapers which have not been sold and publishers' waste. Of course, this newspaper must be collected and brought to the site of reprocessing before it is able to be used.

The cost of collection of waste newsprint must be ascertained as an important part of establishing the economic viability of reprocessing ventures. It is possible to gain an appreciation of the costs involved with collecting newspaper, including the costs of purchasing or hiring baling machinery and trucks, the price of fuel, the costs of transport, labour and overheads such as rent and electricity. The economics of collection also depends on what proportion of the newspaper waste can be recovered ie. the participation rate of the public (Cairncross 1991:203). Publicity of the collection operation is necessary.

Another cost which may be involved with collection is that the generators of the waste may wish to be paid for their contribution to the collection scheme. For example, in Japan, there is a reward to each household for contributing to newspaper recycling in the form of a roll of toilet paper.

Essentially, there are two ways to organise collection of newspapers, and these collection mechanisms can be undertaken with different efficiencies. Either the public sorts out the paper and brings it to a collection site ('bring' scheme), or the rubbish is separated into different bins and placed on the kerbside for collection ('collect' schemes). In Europe, 'bring' schemes are common: specialist contractors pick up separated recyclables from a depot where people have deposited these materials, and little sorting is necessary. Most North American schemes involve kerbside collection. Recyclables are sorted as the collectors go past houses, or they are collected at the kerbside and sorted at a special depot. 'Collect' schemes have also become popular in Germany and Denmark (Cairncross 1991:204).

Approximate costs involved with operating 'bring' and 'collect' schemes in Tasmania can be detailed. Capital costs and operating costs are expressed in terms of 1991 estimates. Capital costs are those costs which will have an impact on the business for an extended period of time, such as the cost of land, buildings, equipment, loan repayments, dividend payments and motor vehicles. Operating costs are those costs which are necessary to keep a business going from day to day, including the cost of goods and materials, salaries, advertising, interest charges and rent.

Estimates of costs are made for operating collection schemes only for newspaper. It is assumed that collection costs will be reduced if materials are collected in combination with other recyclable materials, as it may be possible to reduce operating costs such as labour, vehicle maintenance and rent if paper is collected and sorted using shared facilities.

3.2.1 Estimated Costs of a 'Bring' Scheme in Tasmania

In Australia, 'bring' schemes were a common way to collect newspapers in the past. People often contributed to 'bring' schemes conducted by local groups such as the Boy Scouts, however, the public was not given environmental or cost incentive to contribute to these schemes. Contribution was on good will, and recycling and reprocessing rates were low compared to the total consumption of newspaper.

Community participation in 'bring' schemes is quite high in Europe, particularly in combination with coloured 'street-corner' receptacles for recyclable materials, such as those used in Berlin. One study undertaken by the Warren Spring Laboratory in Britain in 1990 estimated that 'bring' schemes normally recover 10-15% of household waste, having the potential to cut Britain's household total refuse by up to 20% (Cairncross 1991:204). It may be possible that the participation rate of the Australian community in 'bring' schemes could be increased to 30%, considering the expectations of some authors, such as Stanley (1991), for a dramatic increase in the amount of participation in collection schemes in the future. For 30% of people to contribute their newspapers for a 'bring' scheme is optimistic considering current trends in participation, but 30% participation rate to a 'bring' scheme is not unrealistic in the long term if the public have been educated to contribute their newspaper for collection.

To establish the viability of a 'bring' scheme in Tasmania, it is vital to consider the amount of newspaper which may become available for contribution to a 'bring' scheme in Tasmania. In an assessment of the potential for a kerbside collection scheme for newspaper for two semi-urban municipalities in Tasmania for 1991, it was expected that 50 tonnes per month could be collected from a total of 5000 homes in Brighton and New Norfolk (Cretney 1991b). It was assumed that a participation rate of 50% was achievable for participation in this kerbside collection scheme. Where a 30% participation rate may be achievable with a 'bring' scheme, approximately 34 tonnes of newspaper per month may be deposited at a depot from two such areas. In a more urbanised area, such as Hobart or Launceston, the amount of newspaper contributed to a 'bring' scheme may be higher due to the greater population density. It was decided that, for the purpose of this exercise, the cost of operating a 'bring' scheme in a less populated area would be assessed. This is due to the foreseeable need to establish reprocessing in areas which, by necessity, have less of a dependency on interstate export and city-based recycling or reprocessing schemes.

Costs of a 'bring' scheme in Tasmania can be estimated by establishing the costs involved with the rent of a depot and the provision of services such as electricity and the telephone, purchase or rent of a baling machine if necessary, operation of the baling machine and to employ at least one person to sort and bale the paper, and one person to administer the operation. The purchase of vehicles to collect the paper is unnecessary in a 'bring' scheme, although a forklift may be needed to move the paper from the point of disposal to the baling machine. An undercover enclosure in close proximity to the depot must be provided for people to dispose of their waste newspaper.

An estimate of the capital costs for a 'bring' scheme can be outlined. A new baling machine for paper costs in the vicinity of $160,000, including $10,000 for a paper fluffer (D. Peet, Southern Recyclers, pers. comm.). A second-hand baler was purchased by the Hobart City Council for $35,000, but extra costs were incurred in adapting this machine (P. Evans, Hobart City Council, pers. comm.). To pay back a $160,000 loan at a rounded interest rate of 12.75% over a period of 10 years, the loan repayment on the principle was estimated as being $1334 per month, or $16,008 per annum (ANZ Bank representative, pers. comm.). A new forklift would cost approximately $35,000 (D. Peet, Southern Recyclers, pers. comm.). The repayments on a loan of $35,000 at 12.75% interest over a ten year pay-back period would be $292 per month, or $3504 per annum.

Assuming that 34 tonnes of newspaper is delivered to the depot every month, the operating costs of a 'bring' scheme could be approximated.

Table 2: Estimated Annual Operating Costs of Collection of Newspaper by a 'Bring' Scheme in Semi-Urban Tasmania in 1991

Estimated Annual Operating Costs of a 'Bring' Scheme for Collecting Newspaper	**$**
Rent of Depot	24,000 (1)
Electricity, including operation of Baling Machine	4,000 (2)
Labour, including sorting and supervision	4,611 (3)
Promotion	1,000 (4)
Interest on Baling Machine	12,372 (5)
Interest on Forklift	2,700 (6)
Administration and Other Contingencies	1,000 (7)
Total Estimated Annual Operating Costs	**49,683**
Total Estimated Revenue from the sale of 408 tonnes of newspaper at $50 per tonne	**20,400 (8)**
Surplus/ (Deficit)	**(29,283)**

(1) Rent on a depot costs approximately $2,000-$3,000 per month, or at least $24,000 per annum (D. Peet, Southern Recyclers, pers. comm.).
(2) The cost of electricity, including operating a baling machine, is in the vicinity of $4,000 per annum (D. Peet, Southern Recyclers, pers. comm.).
(3) To employ one person to sort and bale the paper would cost $42.68 per week ($2219.36 per annum) if the person was sorting the paper for one hour (to ensure no contamination) and baling the paper for 3 hours, based on a salary of $10.67 per hour. Employing a person for four hours to supervise the operation, organise promotion of the

operation, undertake administrative duties such as payment of wages, and organise the contractors to pick up the newspaper would cost $46.00 per week at a rate of $11.50 per hour, or $2392.00 per annum.
(4) Promotion of the venture is very important, and an extremely conservative figure of $1,000 per annum has been established as the minimum required for publicity of the venture, and includes the use of the telephone.
(5) The interest calculated on a loan of $160,000 for the baling machine, at an interest rate of 12.75% per annum and a payback period of 10 years is calculated as being $1,031 per month.
(6) The interest on a forklift would be $2,700 per annum, at an interest rate of 12.75% per annum and a payback period of 10 years.
(7) Allocation may be needed for unforeseen extra administrative costs, stationery, office furniture and the like.
(8) A separate organisation organises to collect the newspaper from the warehouse, and may offer a certain price for this newspaper. If there is money recouped from the other operator, this may be used used to cover the costs of running the 'bring' scheme. Revenue from the sale of newspaper is based on the price which newspaper was sold for on mainland Australia in September 1991 (Wilkins 1991:2). As shown in Chapter 1, the price of newspaper in the marketplace can fluctuate from $10 per tonne to $100 per tonne, depending on the demand. With the establishment of newspaper reprocessing facilities, the price for newspaper may stabilise. If the demand for newspaper is high, the revenue from the newspaper sold to reprocessors may be high. This may help to justify (in economic terms), the existence of the collection operation.

This total figure of $49,683 to operate a 'bring' scheme may be seen as simplistic. It may be that, in order to run smoothly, the enterprise requires a person to be supervising the operation full-time. The full costs of employing a worker, including superannuation, annual leave provision and sick leave may need to be considered if the employee is to be employed full-time. If this is the case, the full-time person could be employed instead of two part-time employees. Under the Wholesale Trades Award, a level 5 employee is entitled to a wage of $364.00 per week, or $20,832.35 per annum (see Appendix 2). If an employee was employed as such, the operation would cost approximately $65,904. If this was the case, the cost of collecting one tonne of newspaper would be $161.

The cost of collecting 408 tonnes of newspaper by a 'bring' scheme in Tasmania in 1991 is estimated as being in the order of $122 per tonne. If the participation rate for contribution to a 'bring' scheme can be increased to 50%, 624 tonnes of newspaper could be collected from 5,000 homes. With a participation rate of 50%, it would cost $80 to collect one tonne of newspaper from a 'bring' scheme in semi-urban Tasmania. In an urban area, the newspaper contributed to the collection scheme may be close to 624 tonnes per annum without an increase in participation rate, simply because of the greater population density. Revenue from the collection of 624 tonnes, at $50 per tonne, will be $31,200 per annum. Under such sales conditions, the deficit of the 'bring' scheme will be reduced from $29,283 to $18,483.

It may be appropriate to consider the conditions under which a 'bring' scheme could be economically viable in Tasmania. There may be a situation where rent of a premises could be provided (e.g. by a local municipality, or the use of a warehouse could be provided by a donor) and the interest payments on a baler are according to the capacity of the enterprise (e.g. a cheap baler was purchased). If the cost of the rent and the interest on a $160,000 baling machine were deducted from the total estimated annual operating costs of the 'bring' scheme, then the annual profit of the venture would be approximately $7,000. Acknowledging this profit, for the operation to be economically viable, a $55,000 loan at an interest rate of 12.75% could be afforded, if there were no rental payments to be met (ANZ Bank representative, pers. comm.).

3.2.2 Estimated Costs of a 'Collect' Scheme in Tasmania

Costs can be established for kerbside collection of newspaper in Tasmania. Collectors preferentially choose to collect newspaper from publishers, as this paper is clean and often there is one point of collection. There are few risks of contamination of such newspaper stocks. Most of the newspaper available for reprocessing, however, is post-consumer newspaper. Post-consumer newspaper is by far the most difficult and time-consuming newspaper to collect.

It appears that more recyclables are able to be gathered by 'collect' schemes than by 'bring' schemes (Cairncross 1991:204). The participation rate of kerbside collection is probably higher than that of 'bring' schemes due to the convenience of being able to deposit recyclables on the kerbside outside the home, rather than making a trip to the recycling depot. Stanley (1991) suggests that a participation rate of 60% is achievable within about three years with kerbside collection.

There has been a move to increase the level and the co-ordination of 'collect' schemes in many states of Australia, probably due to the perceived likelihood of greater success with 'collect' schemes relative to 'bring' schemes. About five years ago, Victoria and New South Wales first developed multi-material kerbside collection for metropolitan areas, the other states following suit within the past two or three years (Cretney 1991a:4).

In order to run an efficient kerbside collection scheme, it must be made clear when and how the newspapers will be collected. In places such as Geelong, Victoria, kerbside collection of newspaper is undertaken fortnightly, on the same night as the regular garbage collection service. Pamphlets are distributed to explain how to contribute to the collection scheme, and on which nights to contribute. It is important to stress that householders separate their paper from non-recyclables: it has been suggested that all other recyclables except paper can be bundled together, but paper has to be clean from contaminants and dry in order to be recycled or reprocessed (M. Cretney, Tasmanian Recycling and Litter Awareness Council, pers. comm.). This will also ensure ease of handling and sorting for the collectors. If householders or publishers sort newspaper waste reliably, this is cheaper than paying for sorting at the depot to which the paper is taken.

Essentially, in 'collect' schemes for newspapers, householders are asked to tie up their newspaper in bundles, or put a heavyweight on top of the bundle of newspaper, and place this paper near the kerbside of their house. In some areas, special bags are given to the householder to enable them to put their newspaper in. The newspaper is lifted from the kerbside into a truck which has been fitted with a receptacle. The collected newspaper will be taken to a depot for sorting and baling. In turn, the newspaper can be taken to a secure market.

An estimate of the collection costs involved with kerbside collection of newspaper in Tasmania can be calculated. From the calculations of Cretney (1991b), referred to in section 3.2.1, it was suggested that 5 kg of newspaper could be collected from each of 5,000 households in a semi-urban area per fortnight; in other words, approximately 12 tonnes of newspaper could be collected weekly, with a participation rate of 50%.

Capital costs for the machinery used in operating a 'collect' scheme can be outlined. A baling machine for paper costs in the vicinity of \$160,000 (see section 3.2.1). The cost of a 4-tonne truck to collect paper is in the vicinity of \$35,000 (Co-op Toyota representative, pers. comm.). Loan repayments on a \$195,000 loan over a period of 10 years would be \$19,500 per annum (ANZ Bank representative, pers. comm). It is assumed that a forklift would not be required to move paper from one place to another: newspaper will be taken off the truck and put into the baler.

Table 3: Estimated Annual Operating Costs for Kerbside Collection of Newspaper from 5,000 homes in a Semi-Urban area in Tasmania in 1991

Estimated Annual Operating Costs of Kerbside Collection of Newspaper	**$**
Rent of Depot	24,000 (1)
Wages of collectors (staff x hours x $ rates)	9,222 (2)
Wages of balers (staff x hours x $ rates)	6,917 (3)
Electricity, including operation of Baling Machine	4,000 (4)
Fuel for Truck	1,131 (5)
Maintenance on Truck	3,000 (6)
Registration and Insurance of Truck	533 (7)
Interest on Baling Machine and Truck	15,084 (8)
Information Pamphlets	1,000 (9)
Administration and other contingencies	1,000(10)
Total Estimated Annual Operating Costs	**65,887**
Total Estimated Revenue from the sale of 624 tonnes of newspaper at $50 per tonne	**31,200**
Surplus/ (Deficit)	**(34,687)**

(1) see section 3.2.1.
(2) Wages include payment of the driver of the vehicle, a Level 5 employee, for 8 hours at $11.50 per hour: this equates to $4784.00 per annum. Paying a Level 2 offsider for 8 hours per week on casual rates, at $10.67 per hour is equivalent to $85.36 per week, or $4438.72 per annum.
(3) A level 5 and a level 2 employee also need to be employed to bale the paper. Where it was assumed that baling 34 tonnes of newspaper per week takes four hours (see section 3.2.1), it may take approximately six hours to bale 50 tonnes of newspaper per week. A Level 5 employee

would be entitled to $69.00 per week, or $3588.00 per annum. A Level 2 employee would be entitled to $64.02 per week, or $3329.04 per annum.
(4) see section 3.2.1.
(5) Where a four tonne diesel vehicle is driven around to households, it would use approximately 4 litres of diesel fuel per hour (Co-op Toyota Representative, pers. comm.). Diesel fuel is currently approximately $0.68 per litre, so the running costs for a vehicle were established at $2.72 per hour. The vehicle may be required for approximately 8 hours per week, which would mean that diesel fuel costs would be $21.76 per week, or $1131.52 per annum.
(6) The maintenance of a 4-tonne truck which is used intensively for household collection of newspapers has been estimated as $3,000 per annum (Co-op Toyota Representative, pers. comm.).
(7) Registration of a 4-tonne vehicle is $367 per annum, and insurance for the vehicle is approximately $166 per annum (RACT representative, pers. comm.).
(8) The interest payment on $195,000 loan for the baling machine and the 4-tonne vehicle, with a pay-back period of ten years, can be calculated at $15,084 per annum (ANZ Bank representative, pers. comm.).
(9) The cost of information pamphlets, which may prove vital to the establishment of efficient collection systems, was added to the proposed annual costs of the kerbside collection scheme for newspaper.
(10) see section 3.2.1

The cost of collecting newspaper in a semi-urban area in Tasmania by kerbside collection scheme can be estimated at $106 per tonne, where the participation of householders is 50%. If the participation rate of householders was to increase, there would be a greater revenue from the sale of newspaper from kerbside collection.

It must be appreciated that these figures are estimates of costs involved with collection as at 1991. One limitation to these calculations is that interest and loan repayments are calculated on a fixed principle rather than a depreciating principle. The capital costs of collecting newspaper could be reduced by the purchase of second-hand baling machines, and/or the purchase of a second-hand vehicles or forklifts. It may be that a cheap compacting machine could be employed which has been modified from a traditional hay-baler. This acheives a denser bale than with conventional paper bale, which is preferable to handle and transport than a conventional-sized paper bale (R. Alliston, pers. comm.). The output from a modified hay-baler must be recognised as smaller than that of purpose-built balers, however (R. Alliston, pers. comm.). There would be a reduction in loan re-payments required on smaller loans: if outside capital is available, the principle and interest payments may be reduced. Interest charges may alter over time. It may be that premises could be rented at a cheaper rate, that labour costs change, or that it is necessary to inject more money into advertising. The cost factors provided are designed to be a guide to those wishing to establish collection industries in the future.

It may be appropriate to consider the conditions under which a 'collect' scheme could be economically viable in Tasmania. There may be a situation where rent of a premises could be provided (e.g. by a local municipality, or the use of a warehouse could be provided by a donor) and the interest payments on a baler and truck are according to the capacity of the enterprise (e.g. a cheap baler and a cheap truck were purchased). If the cost of the rent and the interest on a $195,000 baling machine and truck were deducted from the total estimated annual operating costs of the 'collect' scheme, then the annual profit of the venture would be approximately $4,400. Acknowledging this profit, for the operation to be economically viable, a $35,000 loan at an interest rate of 12.75% could be afforded, if there were no rental payments to be met (ANZ Bank representative, pers. comm.).

3.2.3 The Importance and the Relevance of Providing Assistance to Collection Industries

The collection of newspaper is expensive. There may be justification for some form of subsidisation on behalf of the newspaper industry, the community or the municipal waste disposal authority in order to encourage the establishment and continuation of a collection scheme which is not economically viable. There must be a recognition of the environmental and cost benefits of avoiding landfill as a method of disposal of waste newspaper.

Newspaper occupies approximately 7.5% of the space in a landfill site. In the short term, it may be that operating costs of collecting waste are reduced if newspaper is diverted from landfill: for example, less fuel would be required to pick up a reduced amount of waste. If less time is required to pick up a reduced garbage stream, savings could be made if the collectors are paid on a casual basis. If the amount of material entering landfill can be reduced by 7.5% by recycling and reprocessing newspaper, it is possible that, eventually, less land will be required to be purchased and prepared for use as landfill. This indicates that long-term savings in capital costs can be made.

To give some indication of approximate monetary savings by avoiding landfill, it may be appropriate to examine some of the costs involved with establishing and operating a landfill site. In Sydney, the replacement cost for a landfill site has been estimated at $266,438,000; in Melbourne, $50,382,000; in Hobart, $4,831,000 (Industry Commmission 1990a:43). It normally costs $350,000 per annum to operate the McRobies Gully landfill site in Hobart, Tasmania (P. Evans, Hobart City Council, pers. comm.). Most regions have not allocated funds to cover more than 5% of the total cost of replacing landfill sites in their respective areas (Industry Commmission 1990a:43).

Accounting for the percentage of waste that is newspaper, and for long term savings, a simplistic approximation of the savings to the Hobart municipality from newspaper recycling or reprocessing could be in the vicinity of at least $26,250 per annum, or 7.5% of $350 000. (The author acknowledges the simplicity of this calculation, but recognises the usefulness of estimating the amount saved in dollar figures). The money which has been 'saved' could be used to reduce the deficit of the 'bring' or the 'collect' scheme for newspaper. Where, after the sale of newspaper at $50 per tonne, there is a deficit of $29,283 for the 'bring' scheme or $34,687 for the collect scheme, this $26,250 could be used to assist either collection scheme. The remainder of the deficit could be made up by funds from a disposal levy on newspapers, for example.

Where newspaper can be sold for $50 per tonne, the annual deficit for each household in a semi-urban area in Tasmania for these schemes is $5.85 for a 'bring' scheme or $6.93 for a 'collect' scheme with participation rates of 30% and 50% respectively. There are various ways to reduce or eliminate this deficit. If the newspaper can be sold at a higher price, the revenue for the paper will increase. If the participation rate of householders increases, the collection scheme may become financially viable due to the increased revenue from the sale of newspaper, if there is not a disproportionate amount of extra effort to be made in collection.

Government of industry could give financial support to collection. If government or industry is not prepared to support collection, it has been suggested that many householders are willing to contribute financially to collection. In a questionnaire undertaken in conjunction with the kerbside collection scheme in two municipalities in Tasmania in 1990, 68% of the participants indicated that they would be willing to pay up to $10.00 per annum per household to support a viable collection service for recyclable materials (Cretney 1991a:38). (Assuming the questionnaire was answered by a representative sample of the community, it would appear that more householders (68%) are willing to pay the $10 than those willing to participate in collection (50%), indicating an apathy in the community to collect, sort and clean recyclables ready for kerbside collection).

The success of collection scheme is what must be ensured in order to encourage the establishment and continuation of reprocessing industries.

3.2.4 The Importance of Marketing Reprocessed Products

It is sufficient to support the collection of materials which have a 'soft' market in the interim, but it is ideal to elevate the demand for waste newsprint. The greater the demand for newspaper by industry, the greater the likelihood of success of the collection industries. The success of a reprocessing industry, in turn, is reliant upon the purchase of the reprocessed items by the consumer.

> "Pursuading citizens to sort their rubbish is only a first step. The other big factor in the economics of recycling schemes is the market for what is collected....Recycling is pointless without a market for re-using materials" (Cairncross 1991:205).

Market research is integral to the proposed establishment of a reprocessing industry. If a product is to be produced, marketing of the product has an important role in the success of the reprocessing industry.

The viability of establishing new reprocessing industries and assisting existing newspaper reprocessing ventures in Tasmania is investigated in this chapter. From existing reprocessing industries interstate and overseas, it was possible to ellicit establishment and operating costs of reprocessing operations in Tasmania, and make an assessment of the viability of the proposals in Tasmania. The possibility that Tasmanian entrepreneurs could become involved in establishing franchises for the production of "new" reprocessed items is investigated.

The market potential for reprocessed items is estimated by analysing the presence of competition with conventional products, comparing the estimated price of the item to similar products, and considering the likelihood for certain items to become fashionable. A review of policy decisions which could assist reprocessing industries in Tasmania has been undertaken.

A major limitation to the study of the market potential for reprocessed items was the (understandable) reticence of business-people to provide information about their knowledge of the market for a product. It must be acknowledged that the costs calculated for the reprocessing industries are expressed in terms of Australian dollars, as of 1991. Calculations may be considered simplistic as allowance was not made for depreciation, inflation and other economic parameters, but it was considered that such parameters are subject to rapid change. Calculations are to be used as a guide only, and the development of new, cheaper technology to produce reprocessed items may change the economic prospects for a potential industry. Appropriate low-scale, low technology options should be considered before expensive machinery is costed and used. If it is considered worthwhile to pursue a reprocessing industry, further technical and economic details may be necessary, and a greater knowledge of the market may be an advantage. entrepreneurs could become involved in establishing franchises for the production of "new" reprocessed items is investigated.

3.3 The EconomicViability of Producing Paper Moulded Products in Tasmania

3.3.1 Paperboard and Cardboard

There is currently no paperboard or cardboard manufacturer in Tasmania. It has been suggested that the amount of paper consumed in Tasmania is far too small to warrant the establishment of facilities to manufacture paperboard or cardboard in this State. The cost of machinery used for the manufacture of cardboard is in the vicinity of $36 million (D. Peet, Southern Recyclers, pers. comm.).

3.3.2 Pulp Moulded Products

John Young, of Pulp Moulding Systems (Australia) Pty. Ltd. investigated the possibility of establishing a Tomlinson Emery pulp moulding machine in Tasmania, with the idea of using pulp moulding techniques to manufacture apple trays for the Tasmanian apple industry. It was proposed that these trays could replace the apple trays which are currently being imported from New Zealand.

It was suggested that the capital costs of establishment of such a machine in Tasmania are prohibitively high, given the estimated revenue.. The perceived demand for pulp moulded products in Tasmania was not high enough to warrant the operation of the enterprise, and the cost of exporting products to the mainland made it difficult to justify the establishment of a machine in Tasmania (John Young, Pulp Moulding Systems, pers. comm.).

Capital costs were seen as prohibitive even when the range of over 18 machines to choose from, catering for production of anywhere between 200 to 33,000 items per hour, was considered. Recently, a firm in Western Australia established a factory with a pulp moulding machine with an initial outlay of $2 million, which included the machine and a workshop (John Young, Pulp Moulding Systems, pers. comm.). Modest estimates of total costs for establishment of Pulp Moulding Machines were given at $1.5 million (Tony Wilkins, News Limited, pers. comm.). The cost of each dye is in the vicinity of $80,000, making it difficult to establish the production of different items due to the high cost (Tony Wilkins, News Limited, pers. comm.).

The possibility exists for the development of cheaper technologies to manufacture paper moulded products in Tasmania. Essentially, the product is simply moulded and dried paper without expensive additives; the development of a low cost, low technology device to manufacture paper moulded products is an option for the future.

3.3.3 Papier Mache Products

Larry Belbin in Hobart sells a composite material called 'Mache Fluff', which is made from a mixture of finely shredded newspaper and food thickener. Mache Fluff is mainly purchased by school groups, and it is also used by taxidermists and model makers at the Tasmanian Museum and Art Gallery. Comprehensive details of the mixture were not able to be given, but it is assumed that the mixture is non-toxic. Mache Fluff can be purchased for $5.50 per kilogram.

If there was an increased demand for papier mache materials in Tasmania, it is likely that these materials could be provided by this supplier. Alternatively, if newspaper is to be used as an art material, it is possible that it can be collected from the homes of students, or from publishers' waste.

3.4 The Potential for Further Development of the Cellulose Insulation Market in Tasmania

From Chapter 2, it has been shown that cellulose insulation, made from newspaper, is an effective form of insulation, and an appropriate means of using old newspaper.

There is currently one cellulose insulation manufacturer in Tasmania. The manufacturers of 'Charlie Fluf' insulation have the capacity to meet an increased demand for cellulose insulation in Tasmania in the future, according to the general manager of the company, Graham Hanna. Currently, the machinery used to manufacture 'Charlie Fluf' insulation is only operating for one day per week; it is assumed that the demand for 'Charlie Fluf' could be increased five-fold before a new business producing cellulose insulation would be warranted.

If the demand for cellulose insulation in Tasmania cannot be met by 'Charlie Fluf', other businesses manufacturing cellulose insulation may need to be established. The OECD (1979:128) has suggested that the costs of establishing a plant to produce cellulose insulation is relatively small. The capacity of the plant may only need to be 10 or 20 tonnes per day.

It is not intended in this study to propose the costs of establishing a new business to manufacture cellulose insulation, but a brief outline of the costs involved may be undertaken. The capital costs for establishment of machinery to manufacture the insulation would approximate $30,000 once the hammermill was purchased. This includes $5-10,000 for the hammermill, $8,000 for the motor, and approximately $5,000 for the electrical switching (G. Hanna, 'Charlie Fluf', pers. comm.). Loan repayments on this machinery may be required. The costs of collection of one tonne of newspaper in a multi-material collection is in the vicinity of $106-122 per tonne (see section 3.2.1-3.2.2). The cost of borates and borax would need to be met. The costs of labour, interest on the machinery and rent would also need to be met.

Cellulose insulation currently produced in Tasmania is competitive with other forms of insulation. 'Charlie Fluf' insulation is available at $1.56 kg, which is equivalent to $5.38 per square metre at a thickness of 100mm and an R value of 2.5. This compares with the cost of fibreglass batts, such as Pink Batts, at approximately $6.50 - $6.70 per square metre, with a thickness of 125 mm and an R value of 2.5. Rock wool insulation, made from molten and spun dolomite, can be bought in loose or batt form. The loose form can be blown in and costs $5.25 per square metre at a thickness of 125 mm and an R value of 2.7. Rock wool batts cost approximately $10.00 per square metre with a thickness of 125 mm and an R value of 2.7.

The likely total market for cellulose insulation in Tasmania was difficult to ascertain due to the confidentiality of manufacturers, but could be estimated. If the average new home is 15 squares, and the whole ceiling was covered by cellulose insulation at 3.4 kilograms per square metre, then each new home would use 510 kilograms of cellulose insulation. If 1250 new homes per annum had cellulose insulation installed,. there would be 637.5 tonnes sold in Tasmania per annum. If 300 existing homes of 12 squares were retrofitted with cellulose insulation per annum, then an extra 122.4 tonnes of cellulose insulation would be required per annum. In all, the cellulose insulation market in Tasmania could be 760 tonnes per annum: where this insulation is sold for $1.56 per kilogram, the sale of this insulation could derive $1.18 million per annum.

Despite the competitive price and the benefits of using cellulose insulation, the sale of this insulation, in recent years, has been limited due to the competition by other insulation manufacturers. According to Dellinger *et al.* (1990:104) the sales of cellulose insulation grew rapidly in the U.S. in the 1970s, but declined in the 1980s due to fibreglass insulation becoming readily available. Effective marketing has given the manufacturers of other forms of insulation a stronghold in the marketplace. With marketing aimed to boost the sales of cellulose insulation, the status of cellulose insulation could be returned.

In Tasmania, the sales of cellulose insulation could be increased with the introduction of incentives to install insulation. Initiatives to assist the sales of cellulose insulation include the development of measures to encourage existing homes to install insulation, and to make it compulsory for new homes and extensions built to install insulation. The Victorian Government has organised a "Keep Vic Fit" advertising campaign. This campaign is organised by the Victorian Government's Greenhouse Program, and is designed to urge the home owners of the 25% of homes which are uninsulated to install insulation, or upgrade their existing insulation. The Victorian Government will legislate to ensure that all new homes will be built to a 'five star standard', which includes insulating walls, ceilings and floors (Victorian Government's Greenhouse Program 1991). The Tasmanian Government could introduce such legislation, encouraging the installation of insulation in the 2000-3000 new homes which are built in Tasmania per year, and the government could also encourage the installation of insulation in all new government buildings. This kind of initiative may lead to an increase in the sales of cellulose insulation, if there is appropriate marketing of the product.

In the past, the Hydro-Electric Commission in Tasmania introduced an incentive to use cellulose insulation in homes in one housing development in Launceston, Tasmania. The Hydro-Electric Commission offered to fit the new houses with cellulose insulation, and the cost of this insulation could be met by periodical payments, rather than as a bulk amount upon installation. The offer was refused by all householders due to the conditional requirement to use electricity as the only source of energy in the home (G. Hanna, 'Charlie Fluf' Insulation, pers. comm.). These kinds of conditions should be removed.

The Government has an important role in encouraging energy efficiency. As such, it has a role in encouraging the use of insulation, and this may provide incentive for the community to purchase cellulose insulation as an appropriate alternative to the use of conventional sources of insulation. Where the potential exists for further sales of this product, the demand should be met. This may alleviate the problems with disposal of newspaper waste, and provide a basis for consistent collection of newspaper.

3.5 The Economic Potential for Newspaper to be used in Agricultural and Horticultural Applications

3.5.1 Domestic Composting

It is assumed that the amount of compost produced domestically will not be enough to warrant the establishment of an economic market for this compost. It may be important, however, to look at economic savings involved with the establishment of domestic composting facilities as a way of dealing with newspaper. For example, backyard composting can reduce the amount of waste entering landfill by 50% if newspaper is included (Victorian Environment Protection Authority, undated). If 50% of waste entering the McRobies Gully landfill site in Hobart, Tasmania could be redirected, the cost of running this site, which is normally $350 000 per annum (P. Evans, Hobart City Council, pers. comm.), could be reduced. The long term savings due to delaying the requirement for new landfill areas will also be apparent. Another way to appreciate the savings to be gained from household composting is to appreciate that fewer trips will be required to be made to the landfill area on behalf of municipal collectors and householders, as there is a reduced volume of waste to be collected. Also, in domestic composting, compostable material does not need to be collected by an external collector, such as in the case of large-scale composting. The processes and costs involved with the collection and manufacture of compost on a large scale are unnecessary.

As such, waste authorities should easily justify setting aside some of the funds normally used for waste disposal for subsidising the purchase of compost bins for householders. Compost bins are considered by many to be an efficient, convenient and tidy way of making compost. These bins are available from most hardware stroes, and in a telephone survey undertaken by the author in Hobart in 1991, bins were found to range in price from $36.95 for a black 150 litre bin to $108 for a larger, more robust and attractive grey-green bin.

In some areas there have already been incentives to encourage home composting by subsidising the purchasing costs of compost bins to householders. For example, the Traralgon City Council in Victoria has organised, through local retailers, that a range of compost bins become available for purchase by local residents at specially discounted prices. The 'Rotoplastic' bins are priced at $35.00 for a 210 litre bin and $45.00 for a 280 litre bin, and these bins are produced from recycled plastics (Leaflet produced by Traralgon City Council).

If home composting is to be used as a method of dealing with some of our waste newsprint, it must be promoted. Razvi *et al.* (1989:66) suggest that for a community to implement composting, including backyard composting, there must be an organisation to take a leadership role, such as a government unit, a private agency or a commercial enterprise. It is vital that this organisation communicates with householders, providing information, selecting the composting techniques which are to be used, co-ordinating the financial aspects, and monitoring the results of the scheme.

3.5.2 Large-Scale Composting

The proposition of establishment of a large-scale composting operation requires an appreciation of the amount of waste which could enter the composting facility, the types of technology available, techniques for collecting compostable waste and an assessment of the potential market for the compost. There must be an appreciation that public information programs are essential in order to encourage people to contribute to the collection of compostable material, to eliminate contaminants in the collection phase and to encourage the sale of compost.

The feasibility of establishing a composting plant in Sydney was undertaken in 1987 by the Working Party on Composting, a branch of the Metropolitan Waste Disposal Authority. After inspection of thirteen composting plants in Europe and Japan, using technologies such as Ebara, Fuji, Vam/Flakt and Trienekens, a number of composting systems were identified as being potentially suitable for the Sydney Metropolitan area.

The capital cost of establishing a composting facility with a design capacity to handle 200 tonnes per day and 60 tonnes per day of sewage sludge was established as being in the order of $15 million (1986 figures). The net operating costs were estimated as being $3,095,278 per annum. In simpler terms, this operating cost was in the vicinity of $45 per tonne of compost. If the machinery could be used in two shifts, producing 400 tonnes per day, the overall operating costs could be reduced to $26 per tonne (Working Party on Composting 1987:2). Figures in Table 4 could be used as a benchmark to detail the costs involved with establishing a composting facility in Hobart. Some of the details such as residual disposal costs and the money from the sale of ferrous metals may differ between Sydney and Hobart, but the calculations may be useful. Figures should be acknowledged as being from 1986.

Table 4 : Average Capital and Operating Costs for a Composting Plant in Australia (1986 figures)

Average Capital & Operating Costs for a Compost Plant

Waste Input/Operating Time	
Refuse tonnes per day (t/d)	200
Sludge t/d (5% total solids)	60
Working days/year	260
Working days/week	5
Working hours/day	8
Waste: total input tonnes/year	67,000
Capital Cost	
Civil works component	$8.4 million
Mechanical component	$6.7 million
Total Australian Cost (1986)	$15.1 million
Operating Costs	$ per year
Amortisation: Civil Work - 20 yrs @ 15%	1,343,530
Mechanical - 15 yrs @ 15%	1,144,788
Labour	350,694
Energy	144,648
Other Services	37,983
Maintenance (2.5% equipment cost)	167,235
Residue Disposal costs - 88 t/d: @ $10.00/tonne	228,800
Gross Operating Costs	
Credits	
Sale of Compost - 56 t/d: assume $15.00/tonne	218,400
Sale of Ferrous Metal - 10 t/d: assume $40.00/tonne	104,000
Net Operating Costs	3,095,278
Cost/Tonne (total waste input 67,600 tonnes/year)	45.79

Based on:
1. labour costs including 60% on-costs
2. power @ $0.12/kw hour
3. diesel fuel @ $0.51/litre
4. water @ $0.36/kl
5. trade waste @ $0.30/kl

Source: Working Party on Composting (1987:15)

For such a composting facility, the total input of waste was 67,600 tonnes per year. Assuming that approximately 50% of material entering landfill is made up of compostable material and newspaper, 70,000 tonnes of material for a composting scheme would be available from Hobart City and Glenorchy in Tasmania, whereby 140,000 tonnes of waste per annum is deposited at landfill sites in these municipalities per annum (J. Wood, Department of Environment and Planning, pers. comm.). As such, a composting facility similar to that costed for Sydney may be appropriate for implementation in urban Tasmania.

Of course, compostable material needs to be collected, which may prove expensive and difficult. Separate pick-up of compostable material requires householders to separate their material carefully. There would need to be a well co-ordinated public campaign to encourage householders to contribute to the scheme.

To justify making compost on a large scale, there must be a large scale, stable market. The ornamental plant industry, turf growers, horticultural services, landscape contractors, market gardeners, or councils could possibly fulfil the demand for compost which has been produced on a large-scale (Razvi *et al.* 1989:66, Working Party on Composting 1987:2) There is also potential for compost to be used as an agricultural soil amendment or as an agricultural fertiliser, where the market for the latter is growing rapidly. Market research by the Department of Agriculture showed that the Australian market for organic fertiliser was 577,000 cubic metres per year in 1987 (Working Party on Composting 1987:2). The potential for compost to be sold in Tasmania needs to be reviewed before consideration is given to establishing a composting plant: the Working Party on Composting (1987:2) has acknowledged that "market development is likely to be a lengthy process".

To establish markets for compostable material, it is important to have stable parameters in quality. Large-scale composting is often fraught with difficulties: odour, contamination of the compost by heavy metals, and the presence of visible contaminants such as plastic and glass can reduce the acceptability of the compost. If kitchen and other compostable wastes are separated at the source, and the introduction of metal, plastic, glass and other contaminants is eliminated, there may be an acceptable end product. Modern composting plants apply screening methods to remove items such as batteries which have entered the composting facility. Standards have been established overseas for heat treatment during the compost process in order to ensure effective pasteurisation (Working Party on Composting 1987:2). Sludge can also be treated to ensure pathogen destruction. Measures can be taken to minimise contamination, and to ensure that quality of the compost is reliable. If these measures are undertaken, the potential for the compost to be marketed may be shown.

The establishment of a large scale composting system in urban Tasmania could be an avenue for disposal of garden and kitchen wastes and for the disposal of certain amounts of waste newspaper, particularly for the disposal of wastes which are difficult to deal with such as soiled newspaper. It may also be an avenue for the disposal of sewage wastes. The savings in landfill costs from establishing a composting plant could be equated as being approximately 50% of the running costs of a landfill site: at McRobies Gully in Hobart, the savings in landfill costs from establishing a composting facility would be in the vicinity of $175,000 per annum. The long term cost savings from large-scale composting may help to justify the establishment of a composting facility in urban Tasmania. It must be recognised, however, that large-scale composting is expensive to establish and operate, and it is vital to establish large, stable markets for the product. It may be more appropriate, at least in the short term, to encourage the use of domestic composting as a way of dealing with compostable wastes in Tasmania.

3.5.3 Hydromulch

Approximately 50-60 hectares of land in Tasmania is covered with hydromulch per year by Spraygreen. Hydromulch is essentially only for large projects, not for small gardens. The demand for hydromulch is currently quite small, but with changes in the commitment of mining companies and government bodies to rehabilitate land, the demand for hydromulch may increase. Mining companies are now obliged to pay Performance Bonds, which are funds set aside to ensure that, upon completion of operations, the company has the finances to afford to rehabilitate the land which they may have scarred. Under proposed amendments to the Tasmanian Environment Protection Act (1973) mining and construction industries may be forced to rehabilitate degenerate land which was the result of their activities. The Department of Roads and Transport may have an obligation, under new amendments to the Act, to ensure that rehabilitation of degraded quarries and dumping sites is undertaken.

The demand for hydromulch in Tasmania will probably only appreciably increase with changes in Government policy towards the rehabilitation of land, and if there is an acceptance of land rehabilitation techniques using hydromulch. It is expected that Spraygreen could meet at least a doubling in the demand for hydromulch in the future in Tasmania (J. Crosswell, Spraygreen, pers. comm.). If the demand for hydromulch was to increase appreciably there may be justification for the establishment of a new hydromulching business in Tasmania. If, in the future, a new hydromulching business is required, it may be useful to briefly outline the capital and operating costs as at 1991.

The capital costs of conventional machinery used in hydromulching is in the vicinity of $100,000 (T. Duckett, Land Rehabilitation Services, pers. comm.), although John Crosswell suggests that the machinery he uses, patented in New Zealand, is cheaper than that of the conventional machinery. Bill Leggett, from 'Aquaseeding' in Melbourne has suggested that he has spent in the vicinity of $200,000 on the machinery for his business, although he could not give definite figures on capital expenditure.

Operating costs include the collection of newspaper, wages, rent, promotion and the purchase of fertiliser. Using machinery such as that used by Spraygreen, paper can be shredded for approximately $80 per tonne, whereas hammermilled fluff from cellulose insulation manufacturers is available for $500 per tonne (price quoted to John Crosswell, Spraygreen, pers. comm.).

Spraygreen now charges $3300 per hectare of hydromulch for large operations, and for smaller jobs, $4800 per hectare. If it costs an average of $4000 to cover one hectare of land by hydromulching, the revenue from covering 60 hectares will be $240,000. Assuming that newspaper makes up the bulk of hydromulch, and an average of 1000 kilograms of hydromulch is applied to each hectare of land, then if 60 hectares of land was rehabilitated with hydromulch, an extra 60 tonnes of newspaper would be required per annum for hydromulching. This would absorb 0.66% of the 9000 tonnes of newspaper consumed in Tasmania per annum.

Until such time as new facilities are required, the community, the government and industry should support existing industries which use hydromulch, such as Spraygreen and Land Rehabiitation Services.

3.5.4 Using Sewage Sludge With Hydromulch

It is possible that existing stockpiles of treated sewage sludge are able to be used in hydromulching as a source of fertiliser. Treated sewage sludge may be cheaper to obtain than conventional fertilisers. 'Aquaseeding', a Melbourne hydromulching company, used sewage sludge which was collected from a municipal sewage treatment plant: the only costs involved were the cost of collecting this material. It is assumed that the sewage treatment plants will provide treated sewage at minimal cost, since the preparation of treated sewage is undertaken as part of the treatment paid for by ratepayers.

Since there are strict guidelines for the use of sewage sludge on agricultural land, extra monitoring of treated sewage waste may be necessary. Costs for this monitoring may be provided by the Hydromulching company, or it may be that the Department of Environment in the respective area will be responsible for monitoring. As it is, monitoring of quality is now undertaken by the sewage treatment plant operators.

It appears that there is increasing demand for and acceptance of fertilisers produced from sewage. Stan Richardson from the sewage treatment plant at Ulverstone, Tasmania, has indicated that there is an excellent demand for the sewage/sawdust mulch produced at the Ulverstone plant (pers. comm.). All of the mulch which can be produced from the plant is sold to householders for use on their nature strips and lawns. The mulch is sold for $15 per cubic metre. It was suggested that the source of sawdust is diminishing, and that new sources of fibre, such as newspaper, will be sought (S. Richardson, pers. comm.). Ulverstone, in the north of Tasmania is semi-urban, with a population of 9924 in 1991 (ABS representative, pers. comm.). The costs for the collection of newspaper from 5,000 homes in semi-urban Tasmania have been established in section 3.2.1 and 3.2.2.

If newspaper is sought as a source of fibre in the mulch, trials will need to be undertaken to test whether this is appropriate. The optimum amount of newspaper to use in this mulch would need to be determined. If, for example, 250 kilograms of newspaper is used to make one cubic metre of mulch, the cost of collecting this newspaper would need to be established. Very tightly packed, one cubic metre of newspaper would weigh on tonne: the costs for collection of newspaper from 5,000 homes in semi-urban Tasmania have been established as between $106-$122 per tonne (see section 3.2.1 and 3.2.2). Therefore, it would cost at least $28.50 for enough fibre to add to one cubic metre of mulch. Where the current mulch is sold for $15 per cubic metre, it is assumed that the sawdust is obtained comparatively cheaply, and that mulch with newspaper would be more expensive to produce. If the customer is prepared to pay for a sewage/paper mulch, it may be appropriate to produce such a mulch. If householders could take their newspaper to the sewage treatment plant, then the producers may benefit from receiving a cheap source of fibre, and offer the mulch at a discounted price to the customer in return for the fibre.

The societal and environmental benefits of using sewage sludge on agricultural land have been discussed in Chapter 2, and include the redirection of sewage away from ocean outfall, avoiding the use of artificial fertiliser and the replenishment of fertility in areas of land where the fertility has been lost. The economic value of the sewage sludge produced in New South Wales (150 dry tonnes per day) is estimated at approximately $2.5 million per year (Awad *et al.* 1989:2).

3.5.5 Vermicomposting

In Chapter 2, the novel idea of establishing vermicomposting systems as bench seats in office buildings was introduced. An established workshop could produce fibreglass bench seats at a cost of $200 (J. Vaughan, Designer/ Builder, pers. comm.). These vermicomposting systems could be marketed for sale in schools or office buildings, and sold for $250 or so. The cost of waste disposal for the school or office with a vermicomposting system can be reduced by as much as 40-50%, whereby the organic component of the waste stream, including newspapers, is reduced.

Worms can be 'farmed', for profit. It would be suitable to establish a worm farm as a small, 'cottage' industry in Tasmania, whereby there would be few overhead costs other than the purchase of the intitial culture of worms, advertising of the venture, and the materials used are waste materials such as old carpet, waste timber and old drums. Worm castings can be sold for $10 per 10 litres. Instant Vegi Gardens in Cygnet, a family-based business working from their home, sell worms for $15 per 1000, or $45 for 3000-5000, mainly to gardeners and to anglers. They undertake very little advertising for their operation.

There is potential for the development of vermicomposting on a more intensive scale for the production of greater quantities of high quality soil amendment and as a source of protein for the diets of fish and poultry. This may require the establishment of a 'more professional' outfit, whereby greater expense is required, but this may not be warranted until the demand cannot be met by 'cottage industry' type operations. Market gardeners and nursery owners could be targeted for the sale of vermicompost. The use of organic fertilisers is becoming a more widely accepted alternative to the use of mass-produced fertilisers. Some species of earthworms, the so-called manure or compost earthworms, have become profitable as production animals in the U.S.A., Canada, England, Italy, Japan, Thailand, Taiwan and many other countries for the production of fish bait and/or for the conversion of organic waste (Reijntjes 1984:139).

Ultimately, municipalities should be willing to support vermicomposting projects as they could diminish their expenses for garbage collection, and there is the potential to reduce the amount of waste newspaper entering landfill.

3.5.6 Animal Bedding

The only equipment that is needed for the production of animal bedding from newspaper is a shredding machine (OECD 1979:128). Security shredding machines are sold by office suppliers, and range in price. The cheapest shredder, capable of cutting A4-sized paper into straight strips, is available for $810. A straight cutting, heavy duty shredder capable of accepting paper 36 centimetres wide is $3948. Heavy-duty cross-cut shredders, capable of cutting 50 or 60 large sheets of paper at a time into squares of 1 or 2 centimetres, are available for $3540 (Representative from McPhee Pty Ltd, Hobart, pers. comm.).

The capital costs of establishing a business to produce animal bedding from newspaper depends on the scale at which the operation is to be undertaken. It is possible that, initially, the manufacture of animal bedding can be performed as a small-scale operation, for example, in a household garage, where the payment of rent on the premises is not required. A shredding machine must be purchased: it is assumed that no loan will be required for the purchase of such machinery. Newspaper which has been collected by a 'bring' or 'collect' scheme will need to be delivered. If re-usable bags are used to wrap the bedding in, such as old wool bales, the cost of packaging can be minimised.

An estimate of the cost of running such an operation is detailed in Table 5, where it is assumed that 50 tonnes of newspaper could be used per year to manufacture bedding. If newspaper is collected from a well-operated 'collect' scheme, the price of newspaper used will be $106 per tonne. A vehicle will be required to collect the paper from the depot of the 'collect' scheme: arrangements may be made for the operators of the collect scheme to deliver the paper to the shredders for $5 per tonne, which will pay for the transport costs and the labour of the driver.

Where 50 tonnes of newspaper is used to make bedding per annum, the cost of making a 40 kilogram bag of bedding is $7.15. The justification for subsidisation of collection of newspaper has been given. Where newspaper collection is subsidised by householders or the municipality, the cost of collecting newspaper by a 'collect' scheme can be re-imbursed, and the paper can be picked up for no charge. This would mean that a 40 kilogram bag of animal bedding made from shredded newspaper in specially made facilities would cost $2.91.

Table 5: Estimated Annual Operating Costs of a Small-Scale Plant to Produce 50 tonnes of Animal Bedding from Newspaper in Tasmania in 1991 (independent of existing facilities)

Estimated Annual Operating Costs of Production of Animal Bedding from Newspaper (unsubsidised)	**$**
50 tonnes newspaper purchased at $106/tonne	5,300
paper delivered to the shredder	250
Wage of one Level 5 employee for 4 hrs/week to oversee the project and shred and package bedding	2,392
Promotion	1,000
Total Estimated Annual Operating Costs	**8,942**

There may be justification for the combination of facilities to produce animal bedding from newspaper with a 'bring' scheme or kerbside collection facilities. Baling would not be required for newspaper, and the electricity cost savings from not baling would reduce the price of the paper to be used in the production of animal bedding. Transporting the paper would not be required, and this would mean that the payment for delivery of the paper would not be required. If the local council, industry or householders subsidise collection, the cost of the collection scheme is re-imbursed, so the latter costs do not encroach upon the running costs of the animal bedding manufacture..

Table 6: Estimated Annual Operating Costs of a Small-Scale Operation to Produce 50 tonnes of Animal Bedding from Newspaper in Tasmania in 1991 (using subsidised newspaper and using the site of existing collection facilities)

Estimated Annual Operating Costs of Production of Animal Bedding from Newspaper (subsidised)	**$**
Cost of labour to shred and package the paper for 3 hours per week on a Level 2 wage	1,664
Promotion	1,000
Total Estimated Annual Operating Cost	**2,664**

(The limitation upon this calculation is that it does not involve payment of a person to be at the site of collection of animal bedding on a full-time basis. It may be that there is a full-time employee who has been employed by the municipality in another capacity who can act as an overseer of the shredding and packaging operations. If it cannot be arranged that a full-time person is available to sell bedding to customers, it must be made clear that animal bedding can only be purchased at certain times. Alternatively, bedding could be distributed to stockfeed outlets, with the added cost of distribution of the bedding to these outlets).

Using the calculations in Table 6 the cost of a 40 kilogram bale of animal bedding made from newspaper would approximate $2.13. This cost compares favourably with the cost of a 40 kilogram bale of straw, which is $2.50 (Geoff Tuting, Monds and Affleck, pers. comm.). It has been suggested that animal bedding made from newspaper last longer than conventional bedding materials. Three 40 kilogram bales of straw are used as bedding for a horse over a period of about two weeks (E. Cunningham, pers. comm.). Two 30 kilogram bags of newspaper bedding last a month (Goldberg 1989:38). So, savings can be made whereby less newspaper bedding is required compared to straw, it lasts longer, and it is cheaper (where the collection of newspaper has been subsidised).

It is apparent that the manufacture of animal bedding from newspaper may be a viable business venture in Tasmania, if the collection of newspaper is appropriately subsidised and existing facilities are used. Market analysis of the potential to use newspaper bedding in Tasmania is recommended, and could be undertaken by consulting existing poultry farms and stables in Tasmania.

3.5.7 Animal Fodder

The viability of producing fodder for ruminant animals in Tasmania was investigated. From section 2.3.8, it was shown that feed pellets for ruminants were composed of variable food materials. Experimentally, newspaper could be safely used for around 10% of the ration, and could be used to replace low-nutrient bulking materials such as oats, straw and grass hay. It has been recognised that the use of newspaper in stockfeed will only be viable when newspaper can be collected for the same price that oats, straw or hay can be produced and collected and treated.

From the literature, it appeared that many of the processes of increasing the digestibility of cellulose by physical or chemical means are still in experimental stage, therefore it is difficult to ascertain the cost of practical implementation of the treatments. Some attempt at estimating the cost of treatments is made below.

Milling of newspaper involves the use of a ball mill: a crude estimate of the cost of such a mill is in the vicinity of $30,000. As cellulose insulation, hammermilled newspaper is available for $1.56 per kilogram, or $62.40 for 40 kilograms. Compared to a 40 kilogram bale of shredded newspaper for $7.15 (see section 3.5.6) or a bale of straw ($2.50), milled paper is very expensive. It is assumed that milling paper is prohibitively expensive as a treatment for improving the digestibility of newspaper.

In the only reference made to the cost of enhancing digestibility, Shuler (1980:44) indicates that the cost of irradiation is too expensive to warrant implementation.

The market for stockfeed in Tasmania was assessed. Not all farmers use stockfeed for their stock: Geoff Tuting from Monds and Affleck estimates that stockfeed is only used by 20% of farmers. The demand for feed pellets for cattle and sheep also depends on the seasons: in winter and in summer, the demand is greatest. It has been estimated that in Tasmania, 6,500 tonnes of stockfeed is sold per annum (T. Swan, Gibsons, pers. comm., Geoff Tuting, Monds and Affleck, pers. comm.). Where approximately 10% of these rations are supplemented by newspaper, there is the potential to use 650 tonnes of newspaper per annum in Tasmania. If 650 tonnes were used, this would represent a 50% increase in the current recycling rate in Tasmania. It must be re-iterated, however, that supplementing feed with newspaper has remained entrenched in the laboratory, and that further research would be required in order to propose an economic rationale.

In bad seasons, the amount of newspaper used may increase. It may be possible to increase the demand for fodder containing newspaper by introducing the latter for use in the export beef and sheep markets and in cattle feedlots.

In the short term, there is a possibility that the availability of straw decreases in drought years and in very wet years. In the long term, it may be that the availability of straw and hay decreases due to a possible decrease in productivity of land, or the competition for farmland to be used for residential areas. In hard times, newspaper may be looked upon as a convenient and cheap supplement to animal fodder.

3. 6 The Economic Potential for Building Materials to be Manufactured from Newspaper

The economic viability of the production of building materials from newspaper in Tasmania has been assessed.

3.6.1 Adhesive-Bonded Fibre Board

It has been assumed, due to the costly nature of the facilities to produce dry-process fibre board, that facilities to manufacture this board (specifically established for the incorporation of newspaper) would be prohibitively expensive for Tasmania. Facilities already exist for the manufacture of particle board in Tasmania, such as at APPM Wesley Vale, and it may be possible to incorporate waste newspaper into the furnish for production of fibre board at mills such as these.

According to Brett Martin, Sales Manager at the particle board mill of APPM, the market for fibre board products which have been made from paper, such as medium-density fibre board, is minimal in Tasmania. The source of medium density fibreboard for the Tasmanian market is currently provided by Australian mainland sources and from New Zealand.

Although people in the industry are reticent to provide information on the possibility of the sales of medium-density fibre board in Tasmania, it could be suggested that, with the broad range of uses of medium-density fibre board, the market potential for its sale in Tasmania may be appreciable. As shown in section 2.4.1, adhesive-bonded fibre board can be used in laminated counter-tops, in furniture making, in cabinets, for interior and exterior cladding, as floor underlay, and in mobile home decking.

From section 2.4.1, it was also found that coffins were being made from adhesive-bonded board, using newspaper. The conservation of forests is an issue which helps to justify making coffins from materials other than wood. According to a 1991 edition of the television program 'Beyond 2000', one million trees are used each year to make coffins in Europe. Where 50 kilograms of wood is used for each coffin, it is obvious that much wood is needed to meet the demand for making conventional coffins. In order to support the use of coffins made with newspaper in Tasmania, these coffins could be imported from mainland Australia. Alternatively, a franchise could be established with the inventors of the technology, Sullivan Fabrications Pty. Ltd, inventors of the technology, who are currently based in Sydney. According to Jeff Allen from Sullivan Fabrications Pty Ltd, once the coffins are available commercially the cost should be comparable to those of conventional coffins. With an average of 3600 deaths in Tasmania per annum (ABS representative, pers. comm.), it may be that the establishment of a franchise for the production of coffins from old newspapers can be economically justified.

Despite the apparent advantages of the use of dry-process fibre board (containing newspaper) in Tasmania, such as the use of a waste material and the possibility of there being a reasonable market for the product, the production of this fibre board involves the use of environmentally and occupationally hazardous substances. Decisions must be made as to the suitability of manufacture of dry-process fibre board as a method of dealing with newspaper waste, with environmental considerations in mind.

3.6.2 Non-Adhesive Bonded Fibre Board

It is difficult to calculate the capital and operating costs of establishing an enterprise to manufacture board without the use of adhesives, as it is not known of any manufacturers of such products in Tasmania or on mainland Australia. It may be that machinery such as that produced by Tomlinson Emery (see section 2.1.2) for pulp moulding could be used to manufacture insulation board or soundboard from waste newspaper. Newspaper can be pulped, moulded and dried using this machinery. It is possible that it could be moulded into large mats or squares for use in ceilings or walls. The Tomlinson Emery machines can be purchased for approximately $1.5-$2 million (see section 3.3.2). Machinery would need to be adapted to facilitate the production of mats or squares of moulded newspaper.

Table 7: Estimated Annual Costs of Operating a Plant to Produce Non-Adhesive Bonded Board in Tasmania in 1991

Estimated Annual Operating Costs to Produce Non-Adhesive Bonded Board from Newspaper	**$**
Rent of Depot	24,000 (1)
Wages	40,157 (2)
Cost of 200 tonnes of Newspaper at $106 per tonne	21,200 (3)
Cost of delivery of newspaper to the depot at $5 tonne	1,000 (4)
Electricity cost	10,000 (5)
Interest on $2 million Loan	154,816 (6)
Promotion	10,000 (7)
Total Estimated Annual Operating Cost	**261,173**
Estimated Cost for one tonne of board	**1,306**

(1) See section 3.2.1

(2) Wages of one full-time Level 5 employee and one full-time Level 2 employee (see Appendix 2)

(3) Newspaper purchased from a 'collect' scheme

(4) An estimate of the cost of delivery of one tonne of newspaper has been given as $5 per tonne, where fuel cost and the cost of labour of the driver of the vehicle are taken into account

(5) The machine used may require the input of large amounts of energy for drying the board

(6) Interest on a loan for $2 million, with a payback period of 10 years and an interest rate of 12.75% will be approximately $154,816.

(7) Promotion of the product will be necessary

The board produced would be available for $1,306 per tonne, or $1.31 per kilogram.

If this product was used as an insulating material, it would be cheaper (per kilogram) than other forms of cellulose insulation (see section 3.4).

Where this board is to be used as a source of insulation, it may be suitable to add material to make the board fire-retardant and vermin resistant, such as boric acid and borax. This may incur extra production costs, increasing the price of manufacture to an equivalent price per kilogram to that of cellulose insulation. If non-adhesive bonded insulation board can be sold for $1.60 per kilogram, the expected revenue from the sale of 200 tonnes of this product would be $320,000 per annum. At such a level of sale, this revenue would cover the operating costs of production, and a profit of approximately $58,827 per annum would be expected.

An estimate of the market for insulation board which can be produced by such a venture is difficult to establish.

The use of insulation board could be encouraged as a way of saving money and precious fossil fuel resources. There are 2,000-3,000 new homes built in Tasmania per year (G. Hanna, 'Charlie Fluf' Insulation, pers. comm.): there may be scope to encourage new home builders to purchase insulation board. The insulating properties of the product would need to be tested. The insulation board could be marketed as an environmentally benign method of insulating relative to the conventional sources of insulation, such as fibreglass.

Soundboard can be used in stairwells, under floors and in walls in hospitals, in factories and in music studios. There may be a limited market for soundboard in Tasmania.

There is the potential to use non-adhesive bonded board for the production of panels such as those made by the Homasote Company in New Jersey, U.S. From section 2.4.2, it was shown that such panel board can be used for sheathing and floor underlayment, or as an interior wall board. The possibility of covering this board in jute for interior finish applications was examined. This board could be installed in new and old buildings.

It has been suggested that the potential market size for wallboards alone in Australia is 30 000 - 50 000 tonnes per annum (Tony Wilkins, Environmental Secretariat, News Limited, pers. comm.). Where

Tasmania has approximately 3% of the population of Australia, the potential market for wallboards in Tasmania is 1,200 tonnes per annum. If it is assumed that 200 tonnes per annum of wallboard made from non-adhesive bonded newspaper is sold, the revenue from this sale (at $1.60 per kilogram) is $320,000. On the merits of selling non-adhesive bonded board as a wall board, this would be a profitable venture. There may also be merit in producing sheathing and floor underlay.

There may be markets for soundboard, insulation board, floor underlayment, sheathing and interior dressing board in Tasmania, although comprehensive market analysis would need to be undertaken to back this statement. One factory could be used for the production of these three items.

The use of waste newspaper may increase if the price of waste kraft paper was either too expensive or unobtainable for addition to Gyprock. If this is the case, the use of waste newspaper may also increase if the market for Gyprock expanded. The campaign to increase sales of gyprock may be accentuated by an acknowledgement that waste paper is often used in the production of gyprock: with an increase in environmental awareness, many consumers are beginning to look for products which are recycled, reprocessed or have a component of re-used material.

In order to assist reprocessing, the community, government and industry could preferentially purchase materials which have a component of re-used material. The U.S. federal Environmental Protection Authority has developed guidelines for recycled content in building products, which could be adopted by the Australian Government.

3.6.3 Bricks

It may be possible to produce bricks using 75-80% newspaper, such as those researched and produced by 'Bettabricks' in New South Wales (see section 2.4.5). 'Bettabricks' is seeking private investors for their business venture, and it may be possible to establish a franchise for the production or sale of these bricks in Tasmania.

It is claimed that 'Bettabricks' can be produced for one quarter of the price of conventional bricks. 'Bettabricks' imported into Tasmania (or produced in Tasmania) are likely to be competitive with conventional bricks. For the consumer, the prospect of a good quality product at an attractive price is very appealing.

Gordon Mitchell, from 'Bettabricks', estimated that his company will collect $6 million revenue in their first year of operation. He also estimated that 8000 brick veneer homes could be made with 250,000 tonnes of waste newspaper per annum. If 8000 brick veneer homes could be made with 250 000 tonnes of waste newspaper per annum, then if 2000 of the new homes built in Tasmania were made from these bricks (locally made), then all available waste newspaper in Tasmania would be required. It is difficult to ascertain the establishment costs of a Bettabricks factory in Tasmania due to confidentiality of the manufacturers, but it is assumed that due to the cheap price and the apparent comparable nature of these bricks, it would be easy to establish a strong market for them. This may justify the establishment of a factory to produce Bettabricks in Tasmania.

Steve Watson from K&D Brick in Hobart has suggested that approximately 0.5% of new buildings in Tasmania per year are made from mudbrick. The demand for hammermilled newspaper to be added to mudbrick homes does not warrant the establishment of special facilities to manufacture hammermilled newspaper: this paper can be purchased from cellulose insulation manufacturers. Hammermilled newspaper can be obtained from 'Charlie Fluf' for $1.56 per kilogram. Clay for mudbrick houses is often obtained from the land on which the houses are to be built. The capital outlay involved with the production of mudbricks made with a component of newspaper is much smaller than the outlay involved with the purchase of conventional bricks, although the abour costs involved with building mudbricks would be high.

3.6.4 Lightweight Aggregate Pellets

The production of lightweight aggregate pellets by the Illawarra Technology Corporation Limited has only been on a trial basis. It would be difficult to ascertain the costs of manufacturing such pellets. In the manufacture of these pellets, the cost of obtaining materials such as newspaper and colliery waste tailings would need to be taken into account, as well as the capital and operating costs of the machinery involved with the manufacture of these pellets.

Lightweight aggregate pellets are aso made by the Neutralysis process. In the Neutralysis process (see section 2.4.5) recyclable materials are removed from the waste stream before the preparation of RDF pellets, which are, in turn, used to manufacture Neutralite pellets. If it is impossible to ensure that waste newspaper is recycled or reprocessed, it may be appropriate to use at least some newspaper for the manufacture of lightweight aggregate pellets in Neutralite. The 25 tonne-a-day Neutralysis pilot plant at Rocklea in Queensland is estimated to have cost at least $1.5 million to establish (Templeton 1990:32). It may be difficult to warrant the outlay of more than $1.5 million in Tasmania to produce lightweight aggregate pellets, due to the perceived small market for such pellets, although the number of uses for these pellets are many and may ultimately increase. At the moment, Neutralite pellets can be used in the manufacture of concrete blocks, and in landscaping and road surfacing.

According to Templeton (1990:33), market analysis in the U.S., the U.K. and Australia has shown that there is considerable use for the aggregate pellets produced by the Neutralysis process, particularly in the production of lightweight concrete blocks. It is not known in which part of Australia the market analysis was undertaken. Where 2,000-3,000 new homes are built in Tasmania per year, and roads are being built or re-sealed, the potential for the production of Neutralite may warrant the establishment of facilities to produce it, and newspaper may be a component in this Neutralite.

Neutralysis Industries is currently undertaking a feasibility study for the New South Wales Waste Management Authority and the Sydney City Council for the implementation of a Neutralysis plant in Sydney. It is suggested that the cost of developing a Neutralysis plant in Tasmania is undertaken by the manufacturers. An added bonus to the processing of lightweight aggregate pellets is that the Neutralysis process generates up to 8MWh of excess energy which can be used in the co-generation of electricity (no information on how this energy is generated has been given in the reference) (Templeton 1990:33).

3.7 The Economic Viability of Treating Hazardous Material Spills with Newspaper

3.7.1 Treating Oil Spills in Water with Hammermilled Newspaper

In order to justify the manufacture of a treatment for oil slicks, it is important to establish the potential market for the treatment. The potential for oil to be spilt must be reviewed.

The Bureau of Transport Economics (1983:3) has characterised the various operations in Australia which may result in spilled oil. It is important to acknowledge that there are several sources of oil pollution. Oil spilt at sea from an oil tanker is one of the least likely events. From the period 1 January 1970 to 30 June 1979, it was estimated that 403 gigalitres of oil were transported near the coast of Australia: there was only one oil spill at sea during this period. This occurred when approximately 2,000 litres of oil was spilled when the *Oceanic Grandeur* ran aground in 1970 (Bureau of Transport Economics 1983:27). It may be more pertinent, at least in the interim, to consider the relevance of applying hammermilled newspaper to oil spills at port. From 1 July 1972 to June 1979 in Australia, there were 334 oil spills in ports alone. Of the oil spilt at ports, oil handling spills accounted for 17% of the total number of spills, miscellaneous spills accounted for 25% of spills and bunkering 58% (Bureau of Transport Economics 1983:9,13).

Estimating the likelihood of a spill, the amount of oil spilt and the type of oil spilt may provide a useful yardstick on which to base calculations of expected treatment stock required and tactical responses to oil spillage. To estimate the oil spill risk, lower and upper confidence limits on the spill rate for each category of spill type can be established. The Bureau of Transport Economics (1983:37) established confidence limits for the occurrence of spills in ports in each of the states in Australia: for example, the possible lower limit on the number of oil spills which could occur in ports in Australia in 1989-1990 was 42, with a confidence level of 92%. There is a 92% chance that there will be at least 5 spills in Sydney and Melbourne ports per year. With a confidence level of 92%, the upper limit on the number of oil spills in Australia in one year is 67, or at least one spill at each port in Australia per year (Bureau of Transport Economics 1983:37).

With 94% and 96% confidence respectively, the upper limit on the amount of oil spills in Hobart is two in Hobart and one in Launceston per annum (Bureau of Transport Economics 1983:37).

Once the probability of an oil spill occurring has been established, it may be useful to determine the largest spill for which port authorities must be prepared. As a backdrop to this information, it is first useful to assess information on the average annual volume of oil spilt at ports in Tasmania (see Table 8).

Table 8: Average Annual Volume of Oil Spilled at Ports in Each State in Australia, 1984-1985.

State	Average Annual Total Volume of Oil Spilled at Ports (litres)
New South Wales	22,300
Victoria	18,410
Queensland	8,510
South Australia	5,070
Western Australia	18,820
Tasmania	2,670
Northern Territory	610
Australia	76,390

Source: adapted from Bureau of Transport Economics (1983:39)

As shown in Table 8, an average of 2 670 litres of oil is spilt in ports in Tasmania per annum. Of course, this is only an average, and it may be that an unprecedented amount of oil is one day spilt from a ship. Tasmanian ports are encouraged to prepare for spills of 300 tonnes at port (R. Hammond, Department of Environment and Planning, pers. comm.).

In order to treat engine oil in water, it was found that the optimum amount of paper to add to the oil was one part paper to ten parts oil (by weight) (see section 2.5.1). If the weight of the oil is not known, but the volume and the type of oil is known, the weight can be calculated. Engine oil, diesel oil and hydraulic oil have densities ranging from 0.870-0.905 kilograms per litre. Crude oil has a density of 0.796 kilograms per litre, but since there are no oil refineries in Tasmania, no crude oil enters Tasmanian ports. If Tasmania must prepare for a spill of 300 tonnes of oil, then it would be most convenient if approximately 30 tonnes of hammermilled newspaper is on hand at each port.

Newspaper could be hammermilled by organisations which are involved with the production of cellulose insulation: 'Charlie Fluf' in Tasmania sells hammermilled newspaper for $500 per tonne, or 50 cents per kilogram (J. Crosswell, Spraygreen, pers. comm.). There may be little justification for establishing facilities for the production of hammermilled newspaper where the demand for hammermilled newspaper is only 30 tonnes, and the demand is inconsistent due to being dependent upon accidental events. If facilities for the production of milled paper are required to be established, costs would include the purchase of newspaper, the purchase a hammermill, rent of a premises, payment of electricity costs and the cost of labour. Hammermills range in price from $15,000- $30,000 (C. Atkins, Cygnet Recyclers Co-operative, G. Hanná, 'Charlie Fluf' Insulation, pers. comm.).

Unlike many other treatments for oil slicks, the application and collection of newspaper adsorbent does not need to be undertaken by skilled labourers. Technicians are required to apply polypropylene and polyurethane. In areas where there is not ready access to skilled people to apply polyurethane, for example, a labour force of unskilled labourers is more likely to be able to be found quickly (to apply newspaper). Since newspaper may be readily available and is relatively inexpensive, it is feasible that materials for fighting the spread of the spill are on hand, rather than needing to be brought in from afar. Hammermilled newspaper could be stored without detrimental effects to adsorbent properties. Oil dispersant has a shelf life which is estimated to be between two and eight years, depending on storage conditions. Excess stockpile of dispersant could be wasted if it is not used within the period of its shelf life (Bureau of Transport Economics 1983:39).

The environmental disadvantages of the use of conventional treatements such as dispersants, and the advantages of using newspaper as a means of adsorbing oil have been outlined in Chapter 2. The use of newspaper as a means of treating oil spills may also have financial benefits compared to the use of other treatments. Unterberg *et al.* (1989:172) observed that 'natural' organic adsorbents tend to be cheaper than natural inorganic adsorbents and synthetic adsorbents.

Treated minerals cost 30-40 times that of natural organic adsorbents (Unterberg *et al.* 1989:172).

There may be justification for allocating hammermilled newspaper and booms, skimmers and pumps to individual ports, according to the likelihood of spillage. Even in areas where little oil is spilt, it remains important to consider the environmental impact of oil spillage, and to go to lengths to avoid oil pollution.

'Mop-up' treatments for oil spills in no way provide the solution to the problem of oil spillage: the way in which oil is transported and handled must be addressed. It may also be valid to suggest that if oil consumption is reduced, the need to transport oil may also be reduced, alleviating the likelihood of spillage to a certain degree. Nevertheless, even after a reduction in the consumption of oil is considered, it is realistic to assume that, at least in the interim, we will have some degree of reliance on oil. The use of newspaper as an adsorbent may be a feasible way to use a waste material such as newspaper, and alleviate the problems associated with oil pollution in waterways.

It is recommended that investigation is undertaken into disposal of newspaper which has adsorbed oil. The possibility of using newspaper soaked with oil as an energy source should be investigated. The most environmentally sound option for disposal should be taken.

3.7.2 Treating Hazardous Material Spills on Land

Apparently sawdust is being used in adsorbing oil spilt in garages. It may be possible to use hammermilled newspaper as an adsorbent for oil spilt on land, avoiding the washing of oil into stormwater drains.

Baramil Holdings Pty Ltd in Victoria have developed a machine to manufacture pellets which are used for the absorption of hazardous materials. This machine cost in the vicinity of $250,000. It is difficult to ascertain the cost of producing such pellets in Tasmania, as information was not able to be given as to the production requirements for the pellets. Baramil holdings may wish to sell their pellets to other states, or to establish a franchise to manufacture these pellets in Tasmania . Baramil Holdings sell these pellets for $13 for a 30 litre bag.

3.8 Potential for the Use of Newspaper as a Dewatering Agent

It is difficult to establish costs for establishment of facilities to use newspaper as a dewatering agent, since existing facilities to dewater are different to the facilities which would be required to dewater with paper. Belt driers and tapered screw conveyors are currently in use for the dewatering of wastes such as sewage wastes. It is appreciated that drying the newspaper through which wastes have been filtered would be energy intensive.

The level of suspended solids which can be removed from suspension by newspaper need to be ascertained. The level of small particles remaining in the water and the method of disposal of this water needs to be established. For example, if the nutrient content of organic waste cannot be adequately reduced by dewatering, the remaining water should not be emptied into waterways where eutrophication can occur.

It may be possible to establish the costs of producing materials from the solids collected from dewatered wastes, where these wastes are put to certain uses. If dewatered colliery wastes and dairy wastes can be added to fuel bricks made from newspaper, for example, reference could be made to the costs of manufacturing fuel bricks in section 3.10.3. There can be benefits of reducing the amount of these weighty solids in the watery waste, and adding mass and flammability to the fuel logs, making these logs a more attractive product. The attractiveness of this product must be assured in order to justify the purchase of logs which are much more expensive than traditional fuel sources.

3.9 Potential for the Sale of File Folders made from Waste Newspaper in Tasmania and Australia

As shown in section 2.8, it is possible to produce office folders from 100% waste newsprint. Such folders are available from Datafile Wrightline in Auburn, Sydney, for prices competitive to that of regular file folders (Anon 1990b:35). These folders are currently being imported from Canada.

There may also be the potential to produce this specialty product in Tasmania from existing supplies of waste newspaper, although it was not possible to establish the cost of the machinery involved with the manufacture of such folders.

Based on estimates from the U.S., the world-wide folder consumption rose by 188,000 tonnes between the years 1980 and 1989, reaching a total of 232,000 tonnes. Despite the introduction of the computer, research by Coopers and Lybrand in the U.S. show that 95% of office records remain on paper. It is thought that 250 million file folders are used annually in Australia, accounting for 334,000 trees. The national retail value is estimated in the region of $45 million (Anon 1990b:35).

In order to investigate the opportunity for folders made from old newspaper to enter the marketplace in Tasmania, the market for lever arch files was investigated, assuming that not all sizes and shapes of folders will initially be made from old newspapers. In the long term, it is envisaged that it will be possible to copy the size and shape of the smaller folders, using old newspapers as a base.

The Department of Purchasing and Sales in Hobart distributes lever arch file folders to Commonwealth and State Government departments throughout Tasmania. For the financial year ending 30th June 1992, 16 800 lever arch files were distributed. It was estimted that a maximum of 10% of the total number of file folders used by government are purchased from other sources, indicating a total usage of file folders by government departments of approximately 18 500 folders per annum (Purchasing and Sales representative, pers. comm.). Angus and Robertson, a major bookstore/newsagency in Hobart sell approximately 1500 lever arch files per year to other users such as students (Angus and Robertson Newsagency representative, pers. comm.). Other newsagencies sell arch file folders: an approximate figure of the amount of arch folders sold/used per year in Tasmania could be 25 000.

Angus and Roberston are currently selling lever arch files for the special price of $3.30 each. If, say, the purchase price is $2.50 for commercial users, and $2.50 for the government suppliers to purchase, and 25 000 are used per annum, then the total consumption of lever arch folders would bring a revenue of approximately $62 500 per annum. If the lever arch files made from newspaper were used to provide half of the market demand, a revenue of $31 250 per annum could be expected.

If the hypothetical venture was also able to tap into half of the market for other folders, and as many of the other folders are used per annum, being sold at a price of $2.00 each, then an additional revenue of $25 000 could be expected. In total, making large and small folders could reap a revenue of $56 250 per annum. If, however, the sales of 'recycled' folders nationwide is expected to reap a retail value of $45 million (see above), then, using extrapolation, the expected retail value for Tasmania would be higher, considering Tasmania has approximately 1/34 the population of Australia.

Information on the production costs of folders from waste newspaper were unable to be ascertained.

3.10 The Economic Viability of Producing Energy from Waste Newspaper in Tasmania

3.10.1 Large-Scale Energy Generation from Waste

The Hydro-Electric Commission established the cost of generating energy from waste in Tasmania in 1987, using various technologies. In summary, it was recognised that the "Generation of electricity from waste does not appear to be economically attractive" (Hydro-Electric Commission 1988:13). This is partly due to the availability of cheap existing sources of power, and the low cost of disposal of waste in landfill in Tasmania.

In establishing the costs of generating energy from waste in Tasmania, it was important to establish the resource which could be utilised: only three landfill sites in Tasmania receive more than 50,000 tonnes of waste per annum (Hydro-Electric Commission 1988:Appendix 2). Where there is comparatively little waste at a landfill site, it may be that the establishment of facilities to produce energy from waste may be unjustifiable in economical terms.

The comparative costs of generating steam or electricity by mass incineration and by the production of RDF can be shown in Table 9:

Table 9: Comparative Costs of Generation of Steam or Electricity by Mass Incineration and by the Production of Refuse Derived Fuels (1987 figures)

Process	Estimated Capital Cost $M	Annual Operating Cost $,000	Energy Cost $/GJ
Rotary Kiln - Steam	30.39	4 523	9.48
Rotary Kiln - Elect.	38.62	5 183	34.86 (12.5 ¢/kWh)
Grate Burning - Steam	30.45	4 443	9.31
Grate Burning - Elect.	39.30	5 158	34.80 (12.5 ¢/kWh)
R D F - 3 Production	5.20	1 547	3.18
R D F - 5 Production	5.80	2 243	4.62
Landfill Gas	0.92	198	2.58

Source: Hydro-Electric Commission (1988:9)

The estimated capital and operating costs for the establishment of mass incineration facilities are high. In fuel enhancement, it is not practical in Tasmania to look at the costs for RDF 2, as this form of energy needs to be used in an adjoining furnace, and there are no facilities for collecting municipal waste in close proximity to furnaces in Tasmania (Hydro-Electric Commission 1988:Appendix 2).

Other authors have suggested that the capital costs for establishing waste-to-energy plants are cheaper. According to Kerr (1990:41), it would cost approximately $2.2 million to establish a plant which could take 20,000 tonnes of waste per annum to generate 1.5 MW. Small plants for generating local sources of energy are available for as low as $100,000. The waste from a country town can be a source of fuel for the local brickworks, an abattoir or the local laundry. Such plants can produce hot gas, like natural gas, at temperatures to 1500°C which can be recirculated for drying fruit, ply or seaweed (Kerr 1990:41). The addition of shredders, conveyors and a fuel storage system needs to be taken into account in costing such a project. Again, it may be that the municipal disposal site is far from the site of use of the energy, so these suggestions may not be viable.

With a population of approximately 500,000, and an annual waste generation of approximately 1-1.5 tonnes per person (Hydro-Electric Commission 1988:5), the amount of waste generated in the whole of Tasmania would approximate 500,000-750,000 tonnes per year.

If, for the purpose of this exercise, it was possible to extrapolate Kerr's figures (see above), it would cost $50 million to establish a plant that would use 500 000 to 750 000 tonnes of waste per year, producing 37.5 MW. Compared to the King and Anthony hydro-electric power generation schemes recently established in Tasmania at a cost of $720 million, producing 112 MW (Hydro-Electric Commission 1989: 14, 24), the establishment cost of facilities to produce energy from waste is relatively inexpensive. If waste is to be collected as it is currently, by municipal authorities, the cost of the input to the energy from waste facility is already accounted for. The capital cost of generating energy from waste is $1.33 million/MW (if Kerr's figures are correct) and generating energy from hydroelectricity is $6.32 million/MW.

The generation of energy from waste is an economically attractive prospect compared to the generation of energy from conventional sources. Energy generation from waste may be an appropriate means of disposing of waste newspaper, assuming that other economically viable means of managing this waste are considered, such as recycling or reprocessing. The generation of electricity in Tasmania is about 1000 MW: if electricity is generated from waste, almost 4% of the required energy could be provided.

The capital costs of the plants which are used to produce ethanol from wastepaper in the U.S. are $US60 million, or, in Australian dollars, approximately $78 million (Salimando 1990:77). Until the cost of such technology can be reduced, or the prototype for a smaller, cheaper plant can be established, the use of acid hydrolysis as a method of dealing with newspaper waste not may be economically viable in Tasmania. There may be justification for the establishment of facilities to produce ethanol from waste in the future if ethanol was used as an alternative fuel in vehicles. The use of ethanol made from cellulose wastes may be an appropriate alternative to the use of fossil fuels.

In the future, there may be a reliance on the generation of energy from waste, due to expected increases in the cost of fossil fuel resources, and the likelihood of a decreased reliance upon hydro-electric sources of power due to political pressures. Our use of fossil fuels such as coal and oil may need to change, due to increased concerns over carbon dioxide emissions and resource depletion. There is also the possibility that landfill areas in Tasmania may become scarce.

3.10.2 Newspaper as an Industrial Fuel Source

It is feasible that newspaper could be used for generating energy in Tasmanian industry, replacing scarce resources such as coal, oil or wood as a source of energy. The calorific value of paper is 17 MJ/kg. Tasmanian coal has a calorific value of 23 MJ/kg (J. Todd, Centre for Environmental Studies, pers. comm.). Fuel oil for use in furnaces has an approximate calorific value of 40 MJ/kg (Representative from Mobil, pers. comm.). Paper, therefore, has 74% of the calorific value of Tasmanian coal, and 43% of the calorific value of oil.

Traditional sources of industrial fuel are used for raising steam in industrial boilers or for use in furnaces or kilns and as a chemical feedstock (Southgate 1981:9). Reference to the use of paper as a substitute source of energy in industrial situations has not been found. To date, there have been investigations into the substitution of coal for oil, such as by Southgate (1981), which concluded that the potential for increasing coal use in industrial boilers is excellent on technical grounds: it may be that newspaper has a similar potential. Coal substitution is also appropriate for applications such as kilns, furnaces and driers (Southgate 1981:9). The effectiveness of newspaper as a source of industrial fuel should be investigated.

"All energy users are naturally sensitive to the costs associated with using a particular fuel and will in general convert to alternative energy cources if it appears economically beneficial to do so" (Southgate 1981:83). The costs involved with using newspaper instead of conventional sources of fuel can be outlined. The price per tonne of coal delivered to the site of use in Tasmania has been established at approximately $68 per tonne (Representative from Merrywood Coal, pers. comm.). Where newspaper provides 74% of the energy of Tasmanian coal, 35% more newspaper by weight is required to produce the same energy value as coal. Where one tonne of newspaper has a calorific value of 17 MJ/kg, 1.35 tonnes of newspaper is required to give the same amount of energy as coal. The cost of collecting 1.35 tonnes of newspaper in Tasmania would be $143-165, where newspaper can be collected for $106-122 per tonne (see sections 3.2.1 and 3.2.2). It may not be economically viable to use newspaper as a substitute for fossil fuels unless newspaper collection is subsidised by householders, the municipality or industry.

The price of fuel oil is $435 per tonne (Representative Tasfuel, pers. comm.). The calorific value of fuel oil is 40 MJ/kg. To generate the equivalent amount of energy from newspaper, 2.35 tonnes of newspaper would be required, which would cost $249-287 to collect. It may be economically viable to replace fuel oil with unsubsidised newspaper as a source of fuel, depending on the capital costs involved with suitably converting burners for the use of paper.

Where boilers, furnaces or kilns are suitable for, or can be adapted for, the combustion of newspaper, there is the possibility of using newspaper as a fuel. It may also be possible to purchase new furnaces for the combustion of newspaper to provide energy. There are many considerations to make in the conversion of one source of energy to another, however. It may be necessary to modify an existing furnace. The change from one source of energy to another "... is essentially a matter of the availability and optimum use of capital funds. The financial circumstances or strucure of the organisation in question will determine the ability to raise funds and several factors such as the age and condition of present steam raising equipment, attractiveness of other projects and the long term strategy of the company or institution will determine if investment is made in this area" (Southgate 1981:83).

It is perceived that the demand for newspaper to be used as a source of energy in Tasmania could be high. In 1980 in Tasmania, in the food sub-sector alone, there were 91 businesses which used oil to generate energy. Coal was used by one business in this industry, and wood was used by three business. In the pulp and paper sub-sector, where large amounts of energy are used, there were 11 establishments which used oil as a source of energy, and four establishments which used a combination of coal and wood for an energy source (Southgate 1981:120). The use of newspaper may have a particular role to play in substituting for oil, as the latter is so expensive.

Using waste newspaper in a furnace should be considered only when no other uses for newspaper can be found. By using newspaper for energy generation, at least the use of fossil fuels is reduced, and the newspaper is not being wasted in a landfill area.

3.10.3 Newspaper Logs

It may be possible to use old newsprint to make fuel logs for use in domestic fires. In 1987, approximately 40% of homes in the Hobart area used woodstoves for domestic heating. In Tasmania alone, the annual consumption of woodfuel in 1987 was 653,000 tonnes (ABS 1987, cited in Todd and Singline 1989:20). Due to increasing concern over the fate of natural areas and the recognition that the use of firewood may have ecological and environmental health impacts, there may be a demand for 'logs' from newspaper waste in Tasmania.

The estimated cost of establishing facilities to produce newsprint logs in Tasmania can be calculated. Newsprint logs can either be produced in a very labour-intensive fashion, or by the use of machinery. Ultimately, these logs can be used as the sole source of heating in a home, or supplement wood as a source of energy.

The operating costs for the establishment of machinery to produce newspaper logs in Tasmania can be outlined in Table 9. The capital cost of the machinery which is used to manufacture newspaper logs in New Zealand is in the vicinity of $50,000 to $100,000 (T. Wilkins, News Limited, pers. comm.). Repayments on a loan for the purchase of a $50,000 machine, at 12.75% interest over a pay-back period of 10 years would be $3,870 per annum (ANZ Bank representative, pers. comm.). Loan repayments on a $35,000 four-tonne vehicle would be $2,700 per annum.

Table 10: The Estimated Annual Cost of Operating Machinery to Produce Newspaper Logs in Tasmania in 1991

Operating Costs of Newspaper Log Manufacture	**$**
Cost of Collecting 300 tonnes of newspaper	31,800 (1)
Electricity, including cost of drying the paper	8,000 (2)
Rent of Depot	24,000 (3)
Labour: two full-time employees	40,157 (4)
Interest on Equipment	3,870 (5)
Interest on Vehicle	2,700 (6)
Fuel costs of Vehicle	1,131 (7)
Maintenance on Vehicle	3,000 (8)
Registration and Insurance of Vehicle	533 (9)
Total Estimated Annual Operating Costs	**115,191**
Total Estimated Revenue from the sale of 300 tonnes of newspaper logs at $50 per tonne	**15,000**
Surplus/ (Deficit)	**(100,191)**

(1) Based on the cost of collecting 300 tonnes of newspaper from a collect scheme in Hobart at $106 per tonne.
(2) It is assumed that it is energy intensive to dry the newspaper logs, so an estimate of the electricity costs of the operation has been indicated
(3) See section 3.2.1.
(4) Payment of one full-time Level 2 employee and one full-time Level 5 employee (see Appendix 2)
(5) Interest payments on a $50,000 loan at 12.75% interest, with a pay-back period of 10 years will be $3870.40 per annum
(6) Interest payments on a $35,000 four-tonne truck with an interest rate of 12.75% and a pay-back period of 10 years would be $2,700 per annum.

(7) A truck would be required to home-deliver the newspaper logs. It is assumed that the logs will mostly be required in winter, and allocation has been made for the distribution of logs for 16 hours per week for six months of the year (see section 3.2.2).
(8) See section 3.2.2.
(9) See section 3.2.2.

The cost of producing one tonne of newsprint logs, assuming that any materials such as dairy wastes which have been added to the logs are obtained at no cost, is $384 per tonne. This is not competitive with the current price of firewood in Tasmania, which is approximately $55 per tonne, depending on the type of wood (J. Todd, pers. comm.). If newspaper collection is subsidised by the community, the municipality or industry to the tune of $13 per tonne, newspaper could be obtained at no cost, leaving the operating costs at $83,391 per annum: this would mean that newspaper logs would cost $277.97 per tonne. The deficit could be reduced by injection of the funds which would normally have been spent on waste newspaper disposal in landfill. Even with such assistance, it would appear that it is uneconomical to use mechanised means of producing newspaper logs in Tasmania. If second-hand equipment or cheaper machinery is used, and loaning capital is unnecessary, the operating costs of the venture may be reduced dramatically.

The author acknowledges that it may be possible to sell more than 300 tonnes of newspaper logs. If, say, 3000 tonnes of newspaper is collected and manufactured into newspaper logs, then the electricity costs and labour costs of production would decrease relative to the increase in the amount of paper collected. Nevertheless, the revenue from such an operation would not be enough to justify the existence of the operation on economic grounds, simply because the cost of collection of the newspaper is much higher than the price at which the reprocessed newspaper is sold.

There is currently a high demand for fuel for woodfires in Tasmania. In the future, the demand for wood may increase, and the supply may decrease, elevating the price of wood. Under such conditions, there may be justification for producing newspaper logs at a competitive price to that of wood. Given that demand for fuel for woodstoves is high, but the use of firewood is seen as a potential threat to forests due to issues such as the removal of invertebrate habitat, the introduction of *Phytophthora cinnamomi* and the removal of cover for small mammals, there may be a place for an alternative fuel source such as newspaper logs.

It is doubtful as to whether newspaper logs would produce less atmospheric emissions than woodfuel (J. Todd, Centre for Environmental Studies, pers. comm.), but an assessment of emissions from such logs would need to be undertaken before thier use is considered, since atmospheric pollutants from wood fires is currently an important health issue in Tasmania. Once this is considered, it may be that the 'unquantifiable' environmental attributes of newspaper logs may help to justify community, governmental and industry assistance for this kind of venture.

3.11 Summary

On current economic terms, it could be shown that most of the proposed options for reprocessing newspaper in Tasmania are not viable, with the exception of the use of newspaper as an industrial fuel source and the manufacture of panelboard using non-adhesive methods of binding. Where subsidisation has occurred, the option of producing animal bedding from newspaper is attractive. There is the potential for greater community and governmental support for existing newspaper reprocessing industries such as 'Charlie Fluf' insulation and Spraygreen. Due to the large market for office folders, the potential for development of technology to manufacture these items from waste newspaper should be investigated. Under franchise agreements, there is the possibility of producing items in Tasmania which are being produced in other Australian states, such as lightweight aggregate pellets and Bettabricks.

The results of the investigation into the economic issues and viability of options can be summarised in tabular form (see Table 11).

Table 11: Results of Investigation into the Economic Potential of Options for Reprocessing Newspaper in Tasmania in 1991

Economic Potential	Proposed Option
Economically Viable in 1991	*Industrial fuel *Non-adhesive bonded fibre board
Probably economicaly viable with a change in Government policy and/or a strong marketing campaign	*Hydromulch *Insulation
Possibly Economically viable, but more research required	*Bettabricks *Folders *Insulation board *Lightweight aggregate pellets *food source for ruminants

It must be emphasised that the economic feasibility of options for reprocessing newspaper was assessed in terms of using the whole of Tasmania as a market. It may be that using cheaper, lower scale technology and reducing overhead costs by using shared facilities may make reprocessing feasible for a local community. The corollary to this is that reprocessing may be viable if markets for the products were sought on the Australian mainland or overseas, taking into account freight costs.

There is acknowledgement that the terms which are used to define whether a project will go ahead or not (economic viability) do not account for the environmental and social benefits which could be gained from the establishment of a project. In making decisions based on these estimates of costs, it must be established whether or not the business is designed to simply make a profit, or to provide an avenue for taking advantage of the resources invested in the manufacture of newspaper.

It must be remembered that encapsulating the resources which have been invested in the manufacture of newspaper is very important. In

Chapter 1, the disadvantages of continuing the use of virgin resources in the manufacture of paper was discussed. "Even though the fundamental capital that all countries depend on is the natural world, modern economics makes no sense. When a business person evaluates a forest, for example, that ecosystem is transferred into 'board feet' or 'cubic metres' that can then be plugged into the proper equations ... considerations of the worth of *not* touching the forest are dismissed as 'externalities' to the economic evaluations" (Suzuki 1990:114).

In the same way, externalities such as the worth of reducing the litter, traffic, vermin, odours, and leachate from landfill, reducing energy consumption, reducing the use of water, reducing the Greenhouse Effect and maintaining environmental quality have not been included in these calculations of economic viability of reprocessing. The author acknowledges that these 'externalities' should become involved in the calculations, and that many of the projects could become viable if expressed in terms of an economics which considered the environment.

The community, municipal authorities, the Federal Government or industry may justify the subsidisation of reprocessing industries which do not operate on a profit basis where there are savings in landfill costs and environmental advantages.

CHAPTER 4

RECOMMENDATIONS FOR THE EFFECTIVE MANAGEMENT OF NEWSPAPER WASTE IN AUSTRALIA

Ultimately, the best way to manage newspaper waste is to avoid producing it. There are arguments for reducing the amount of newspaper produced, reducing the size of newspapers, and for segregating newspaper into component parts for purchase. If paper cannot be conserved or re-used, it can be recycled or reprocessed.

It is important to acknowledge that recycling and reprocessing ventures must be economically viable in order to survive. Granted, this is the case for any industry, but some may argue that it is particularly difficult to establish recycling and reprocessing industries, due to the lack of infrastructure for collecting the waste, the cost of technologies to establish recycling industries, the stigma attached to reprocessed items and various forms of existing government policy. It may be possible to provide financial, policy or legislative assistance to collection and reprocessing and recycling industries, justified by the recognition of the benefits of reprocessing and recycling by the community, industry and the government. Like Vincent (1988a:4), many appreciate that, at the moment, "the market does not take into account the social and environmental costs of wasting secondary resources and the use of finite primary resources".

Many mechanisms of assistance have been introduced and trialled overseas, and lessons can be learnt from such experiences in order to alleviate problems with reprocessing in Australia. It is vital that collection of newspapers continues and that the demand for waste newspapers is met by successful recycling or reprocessing operations. The reputation of collection, recycleing or reprocessing industries must be upheld to ensure efficient and consistent redirection of waste newsprint from landfill into more permanent uses.

Government, industry and the community can have a role in approaching an optimal level of newspaper reprocessing and recycling in Australia. The 'optimal level' of reprocessing and recycling may be defined as the level at which reprocessing and recycling are conducted which appreciates all of the energy and resources which went into the making of newspaper (the environmental costs), without a massive waste in energy and resources being used to collect or reprocess this newspaper, or large amounts of pollutants being produced. In many areas, the optimum level of recycling or reprocessing has not been met: there are large amounts of newspaper being wasted which could readily be collected and reprocessed with minimal amounts of pollutants. Recycling and reprocessing must be undertaken for environmental reasons, not for the sake of political reasons or trends.

A number of recommendations for reaching an optimal level of recycling or reprocessing are described.

4.1 Discourage the Provision of Cheap Virgin Resources

Many in the environment movement argue that natural resources, both renewable and finite, are being made available to industry at too low a cost. Industry, of course, would dispute this. If recycling and reprocessing are to be encouraged, however, one option is to increase the cost of virgin raw materials. The price of virgin wood fibre in Australia is low: this is damaging the market for recycled goods (Cairncross 1991:212). Pulp and paper companies have access to the forests, and it is comparatively cheap to produce newspaper from wood, therefore, recycling and reprocessing are not primary considerations. Governments should tax virgin raw materials in order to indirectly increase recycling or reprocessing. An increase in the royalties for pulplogs supplied to the pulp and paper industries from the public forests may eventually have an impact on the level of reprocessing.

> "Given existing investments in pulp and paper mills, higher wood prices would be unlikely to have a major effect on paper recycling in the short term. But reforms in this area would mean that, in the longer term, forests would be used more efficiently and recycling would increase" (Industry Commission 1990a:6).

Increasing the price of virgin timber may also act as an economic incentive for builders to use materials which have been produced from reprocessed newspaper, particularly if the latter can be produced and sold at a relatively low price.

The government could reassess the inflexible agreements which assure that forestry concessionnaires have exclusive rights to native forests for periods such as 80 years. In order to increase recycling, it could be agreed that there must be a move away from the automatic use of virgin resources.

The government should appreciate the environmental costs of providing cheap electricity to major energy users. A wide-ranging increase in the price of electricity would encourage conservation of resources such as coal, reduce Greenhouse Gas emissions and reduce the amount of newspaper produced from virgin wood, as thermomechanical pulping is energy intensive. There may be incentive to produce more newspaper from old newspaper, and a concomitant increase in the demand for old newspapers. Technologies for producing 100% recycled newspaper are becoming available, and, eventually, the purchase of such new technologies may be rationalised by the necessity to reduce electricity costs.

4.2 Increase the Cost of Disposal

A fundamental way to encourage an optimal level of recycling/reprocessing is via the introduction of elevated waste disposal costs. The environmental and social costs of waste disposal in landfill or by incineration have been discussed in Chapter 1: the Industry Commission (1990b:78) indicates that "Waste management charges do not give users clear signals as to the real costs of paper disposal". It is very expensive to operate landfill sites, and increasingly difficult to find new sites due to environmental regulations, escalating land prices and community opposition. If ratepayers and industry are charged according to how much waste they generate, using the 'Polluter Pays' Principle, there may be more incentive to reduce the material entering landfill by sorting and collecting materials for recycling and reprocessing. In Seattle, Washington State, there is a flat-rate fee for rubbish services and a larger fee is charged for extra bins or even half bin loads (Cairncross 1991:20). Fines for illegal dumping of material should be increased dramatically.

Funds generated by applying elevated landfill charges (where people have not contributed to recycling or reprocessing) can be used to encourage the development of collection industries or recycling or reprocessing industries. In turn, with an increase of the available secondary materials, potential recyclers or reprocessors may see the demand for these resources to be collected and reprocessed or recycled.

Local government has a role in establishing realistic waste management costs, which take account of the long-term environmental costs of landfilling. The Government could introduce disposal levies on materials which are difficult to dispose of, such as plastic packaging, and use the revenue from this levy to fund collection, recycling or reprocessing of newspaper. Pricing structures which adequately reflect the environmental costs of the product should be implemented (the 'User Pays' Principle). The price of newspaper should be increased, for example, by 3-5 cents per copy, and the increment by which it is increased should be allocated for the management of newspaper waste.

Many members of the community appreciate the benefits of recycling and reprocessing: section 3.2.3 highlighted the willingness of the community to pay $10 per annum for the collection of recyclables from their homes. Municipal authorities could harness this willingness to contribute by increasing rate payments in order to fund collection of newspaper.

Cretney (1991a:37) suggests that industries whose commodities are collected should pay more for the collection of their waste than the community. This can be paid voluntarily or by legislative measures such as disposal levies.

4.3 Assist Collection of Newspaper

Problems associated with the collection of newspaper include a lack of infrastructure to support reprocessing such as collection substations and kerbside collection operations, transport costs involved with collection, a lack of community participation in the collection and a lack of stability in the price of newspaper which is taken from the newspaper collectors. The latter encourages instability in the collection industry.

In Australia, there are an increasing number of kerbside and 'bring' collection stations being established, but these are mostly in metropolitan areas. Local government and industry should estimate the money to be saved by avoiding landfilling of newspaper, and use the savings to support local collection recycling or reprocessing schemes for newspaper. It is cheaper for the Waste Management Authority in Sydney to provide a rebate to City Council waste paper collectors of $17.50 per tonne, than to allow the disposal of this waste by landfilling at $32 per tonne. The PNEB offers a subsidy for the collection of newspaper in Sydney of $25 per tonne (T. Wilkins, Environmental Secretariat, News Limited, pers. comm.).

It has been suggested that it is more likely for a kerbside collection for newspaper to be viable if it is undertaken in conjunction with multi-material collections (M. Cretney, Tasmanian Recycling and Litter Awareness Council, pers. comm.). Where the market for materials such as glass, office paper and aluminium cans is well established, the revenue to be gained from these materials could be used to support the collection of materials for which there are 'soft' markets, such as newspaper. Local government or collection industries could organise the distribution of funding for newspaper collection.

A major impediment to collection of newspaper is the cost of transport. It may not be considered appropriate to subsidise transport costs for collection industries in a time of encouraging efficiency of fuel use. Instead, efficiency in collection should be encouraged. For example, great distances should not be travelled for small amounts of newspaper if it is possible to travel shorter distances to collect paper, and collect more of it. If most householders can be encouraged to contribute to kerbside collection, the vehicles collecting the newspaper will be able to collect more paper in fewer trips, improving the efficiency of collection. Newspaper publishers could have a role in assisting collection: after distribution of newspapers to retail outlets, it may be possible, on the return trip, to collect old newspapers from the outlet and take these papers to a collection depot. This would rely on customers returning their old newspapers to their retail outlet.

Another impediment to the existence of collection facilities is the lack of community participation in collection. In a report prepared by Cretney (1991a:32), the participation rate in a multi-material collection scheme in one municipality in Tasmania in 1990-1991 was less than 25%. A shortfall in newspaper collected could be ameliorated after encouraging a greater participation rate in the contribution of newspapers to the 'bring' or kerbside collection schemes. The newspaper industry, local, state and federal government and community groups could organise such campaigns. Public information campaigns could potentially have the effect of increasing the participation rate in kerbside collection, particularly if the benefits to the householder are acknowledged in these campaigns. Stanley (1991) suggests that participation in collection schemes could increase to 60% in the next few years. Contribution to collection schemes may be the factor which is vital in the efficiency of the collection scheme: otherwise collection attempts may be to no avail. "Recycling will be cheaper if it draws on the co-operation of a well-motivated public"

(Cairncross 1991:204). Promotion of collection operations must be undertaken.

In many areas, participation in collection is high. For example, in San Jose, California, 55-60% of households took part in their local 'collect' schemes through their own compulsion, indicating that "a sense of moral obligation is the main thing that drives this programme" (Harbert, cited in Cairncross 1991:204). The participation rate in the Seattle kerbside collection scheme is 90% of eligible households (Cairncross 1991:204). If participation rates in Australian kerbside collections are low, such incentives such as education and extra garbage disposal fees should be introduced.

Even if well-motivated, there must be an acknowledgement that the community will probably choose the most convenient option for disposal of their newspapers. Kerbside collection of newspaper is convenient for householders, as is the positioning of waste receptacles on street corners, as in Europe. Collectors of newspaper should investigate the likelihood of co-operation by the community, and the facilities which would best suit the community. Collection agencies need to provide accurate information about when and where newspapers will be collected.

Increasingly, it is becoming important to improve the professional image of collectors. Cretney (1991a:37) indicates that collectors should continually monitor, modify and improve the efficiency of their sorting and collection. Support and training for collectors may be required in the area of small business management, and in developing low technology sorting and collection facilities (Cretney 1991a:29). People may be encouraged to collect newspapers if the operation with which they deal is streamlined, efficient and reliable (R. Alliston, pers. comm.).

At the same time, however, care must be taken to ensure that the public does not simply see the collection industry as a commercial venture. The phenomenon of householders refusing to let collectors have their recyclables for fear of the collectors making money has been noticed (R. Alliston, pers. comm.). The collection industry should advertise themselves as being socially and environmentally responsible, not purely as commercial operators.

The community may be reticent to contribute their newspaper for kerbside collection, as they already contribute their papers to a charity. Kerbside collection should not interfere with people's desire to be charitable. To retain or establish goodwill, it may be that kerbside collectors offer the charity a proportion of their revenue, in light of the business which the kerbside collectors may have taken away from the charity. It is vital that collectors appreciate the desires of the community.

Cairncross (1991:204) acknowledges the attraction of involving 'green' groups in collection schemes: Friends of the Earth have helped to launch the 'collect' scheme in Sheffield, England. In Germany and France, voluntary groups run campaigns to pursuade people to recycle waste, and the collection company pay the voluntary group a certain fee per tonne of waste collected. Community groups could have a role in assisting collection of recyclables.

Lack of stability in the price which is paid to collectors of newspaper is one reason for the demise of many collection industries in Australia. Investigation of collection systems overseas may prove of some benefit in order to encourage stable collection schemes for newspaper in Australia. The OECD (1979:90) refers to the use of buffer schemes, which operate by with-holding some of the material in times where the price for that material is low, and selling the material when the demand for the material is high. Suppliers earnings can be regulated so as to be able to provide an income in times of low demand (OECD 1979:90). Collection industries should investigate and implement such options for the stability of their operations, assisted by municipal authorities if necessary. Cretney (1991a:37) suggests that the State Government (in Tasmania) could assist the funding of kerbside collection. The idea of granting financial assistance to collection agencies who cannot operate economically but appreciate the net benefits of collection is now beginning to receive formal status (OECD 1979:59).

The establishment of a consistent, non-fluctuating price for newspaper is dependent upon the establishment of a demand by successful recycling or reprocessing industries.

4.4 Encourage the Establishment of Recycling and Reprocessing Industries

Assistance could be provided to encourage the establishment of recycling and reprocessing industries by establishing low-interest loans, financial assistance and tax incentives. When undertaken by government, these incentives are not legislative measures, but budgetary measures.

Some may argue that a measure of the success of a reprocessing venture would include independence from intervention by the community, government or by industry. The measure of success of a recycling or reprocessing industry should be defined as the success with which the venture deals with waste material, with a high degree of economic independence, efficiency of energy use and low levels of pollution. If, in order to survive, a reprocessing or recycling venture requires assistance from the community, government or industry, the environmental and social attributes of this venture should be assessed and the possibility of interventionary assistance should be reviewed.

It may be appropriate for the government to provide low interest loans to prospective reprocessing ventures where the capital costs for the operation are prohibitively high, but the operating costs can be met. Through the Tasmanian Development Authority (TDA) there is the provision for granting low interest loans to proposed developments. Under Section 37 of the TDA Act, the Tasmanian Government should enforce the support of 'socially desirable' (*sic.*) activities which have a degree of economic independence but require assistance (Bakker *et al.* 1990:Ch 5).

It may be that interim financial assistance is required where it takes a long time for the market for a reprocessed item to be established. Assistance could be appropriate where there is only a relatively small shortfall in the operating costs of the business, but the enterprise is considered an appropriate means of dealing with a waste material. Funds could be raised by elevating landfill charges or from disposal levies on 'difficult-to-dispose-of' wastes. Cairncross (1991:212) suggests that governments could also subsidise recycling or reprocessing by providing cash.

Reprocessing industries are labelled 'manufacturing industries'; these industries pay heavy taxes on equipment such as forklifts. Government should intervene to redefine the status of recycling and reprocessing industries, and reduce the tax on machinery.

If assistance is to be provided for the establishment and the continuation of reprocessing industries, it is essential to determine exactly what a recycling or reprocessing industry is. Until such time as a recycling or reprocessing industry has been defined, a moratorium on the provision of financial assistance, low interest loans and tax incentives should exist, otherwise there will be many organisations who pollute or who recycle or reprocess very little to 'jump on the bandwagon', attempting to reap the benefits.

4.5 Pursue Research and Development into Recycling and Reprocessing of Newspaper

The pressure to deal with newspaper waste.....

> "has resulted in the great challenge of finding environmentally benign, low cost disposal and recycling methods for an enormous accumulation of waste products. Therefore, in contemporary terms, we must create expanded capability for research and development if we are to provide innovative, economical, and efficient processes to protect the environment" (Setterholm 1991:79).

Government and industry need to pursue research and development in the area of recycling and reprocessing, and create market niches for new products. The government should give tax concessions to organisations which conduct research into uses for waste materials.

Levies on non-renewable resource use, contributors to landfill and on other polluters should be used to support research and into developing new techniques to produce recycled or reprocessed products. The best available technology should be sought for the production of reprocessed or recycled goods, with the aim in mind of producing minimal amounts of pollution.

4.6 Accept Recycled or Reprocessed Products

The success of reprocessing or recycling industries is dependent, in part, upon consumer preferences and the likelihood of reprocessed or recycled items to be able to replace traditional items.

The community should appreciate that acceptance of recycled or reprocessed products has an important impact on the production of such items. Without a demand for a product, there is little justification for investment in the technology, the time or the energy required for its production. Increased acceptance of recycled newsprint has led to increased facilities to make recycled newspaper in the U.S., where there were 9 mills which accepted old newspaper (ONP) in 1989, and 26 mills accepting ONP in 1991 (Victorian Government 1991:16). If non-de-inked newspaper was demanded by the consumers, and, in turn, the advertisers, the delays in establishment of de-inking recycling facilities, due to environmental concerns, may be avoided. A relatively non-polluting technology to produce recycled paper without de-inking is used by Steinbeis in Germany: the costs of establishing such a machine in Australia is dependent upon the demand for non-de-inked paper in Australia. It is possible to produce quality recycled paper without de-inking (Vincent 1988a:9). Non-de-inked newspaper has been produced in the U.S. for 30 years.

Recycling and reprocessing industries should move to meet the demand of the consumer. These industries should also ensure that good quality items are produced, and that these items are widely available.

Industry should use marketing techniques to encourage the purchase of recycled and reprocessed items. Marketing is an essential tool for any reprocessing operation, to ensure economic survival. It is important to recognise market orientation, in other words, *who* the product will be sold to, and *what* the product is that is to be sold. There must be a clear idea of the demand which the item could meet. There must be a knowledge of the potential competition for the product. Such information can be gleaned from market research. If there are aspects of the product which can be marketed successfully, these aspects should be advertised.

Subsidies could be provided by government or industry for the preferential sale of reprocessed items in order to encourage the establishment and continuation of reprocessing or recycling industries. Sales tax exemption should be given on recycled or reprocessed products where the production of these items is initialy expensive and costs are not competitive with traditional items. The success of the reduction in price of recycled goods should be monitored. To date, little research has been undertaken in order to guage the success of tax relief, but it is assumed that it will encourage the purchase of recycled paper by consumers, and may be useful in encouraging the sale of reprocessed paper products.

Of course, sales tax exemption should not be given for a product which has no usefulness, otherwise the government bears a heavy financial load. If reduced price is not the mechanism for increased acceptability of the product, other reasons for the lack of sale of the material must be assessed. If marketing the product is essential, there may be a role for the government to 'kick start' marketing in order to encourage the acceptance of the product by the public.

The government and the private sector should organise the preferential purchasing of recycled or reprocessed products. Again, recycled or reprocessed items must be clearly defined.

4.7 Legislate if Necessary

There is acknowledgement that "Left entirely to the the market, some recycling will occur, but at rates that do not reflect the environmental costs of extracting raw materials or disposing of rubbish" (Cairncross 1991:201). This has led to consideration of legislative measures to increase the level of recycling and reprocessing. Conservation groups often see that mandated solutions are necessary to increase the level of reprocessing and recycling in Australia. On the other hand, there appears to be consensus among newspaper producers in Australia which indicates a general opposition to "heavy-handed" legislative options, essentially because mandatory collection and targets for the use of waste material are seen to encourage "recycling for recycling's sake", rather than to achieve efficiency. It is not within the bounds of this thesis to undertake a comprehensive discussion into the merits and disadvantages of legislation, but some of the points of contention can be outlined, and some of the merits of applying legislation as an option to increase the level of recycling and reprocessing can be pointed out.

Essentially, legislation is not necessary if an optimum level of recycling or reprocessing can be achieved by industry. This would probably satisfy the government, conservation groups and industry. The problem is "How do we ascertain the optimum level of newspaper recycling?" Minimal landfilling, efficiency of fuel use, minimal use of raw materials and the efficient use of energy are prime considerations. Once the optimal level of reprocessing/recycling is established by consultation with government, industry and conservation groups, industry should be consulted as to whether this level is achievable without legislation.

Legislation to enforce recycling may not be necessary if the newspaper industry can achieve an appropriately high level of recycling. For some reason, industry prefers to set their own targets for recycling and reprocessing, based on the level at which they acknowledge that the market, rather than the government, could work to achieve an elevated level of recycling or reprocessing. The newspaper industry believes that government targets are detrimental to up-and-coming paper industries (Russell Fagg, National Recycling Manager, ANM, pers. comm.). The newspaper industry believes that government targets

> "would in fact be counterproductive, damaging developing export markets, reducing availability of old newspapers and raising the price for existing industries" (Young 1991:5).

The observation that collection works best when not enforced may have credence for the community also: householders, when forced to co-operate in collection, are often less likely to co-operate (Cairncross 1991:205). According to Cairncross, collection will

> "... work best if cities or voluntary bodies make it as easy as possible for housholds, but then allow a warm glow of self-righteousness to be their main reward" (Cairncross 1991:205).

Contamination often occurs where householders are forced to contribute to collection.

Lunn (1991:29) suggests that legislation designed to increase the level of recycling and reprocessing in the U.S. is bureaucratically unwieldy and only serves to establish a recycling rate which is marginally higher than the level of recycling in Australia, where there is no legislation. Despite the disadvantages of implementing legislation, there may be benefit in acheiving a marginally higher recycling rate than industry can achieve, not necessarily in economic or bureaucratic terms, but in environmental terms.

If it is decided that legislation to encourage the return of waste materials is necessary to encourage an optimal level of recycling or reprocessing, then moves must be taken to ensure that the infrastructure is in place to support collection, recycling and reprocessing. Lessons should be learnt from the experiences of imposing legislation in New Jersey, whereby the legislation has been streamlined to accomodate new ideas for efficiency. Initially in New Jersey, 25% of the state's municipal waste was targeted for recycling. A statewide landfill surcharge was used to establish the state's recycling fund, part of which, in turn, was used to help publicity and educational activities concerning recycling, for low interest loans for recycling operators, for state administration expenses and for personnel and administration expenses involved in recycling (Vincent 1988a:15). With landfill costs expected to increase by 200-250% by 1990, modifications were required to the Act. In 1987 a revised Act was introduced, whereby there was acknowledgement that with increased amounts of recyclables collected, there could be a price crash with associated collapse of businesses.

The new legislation was able to have a "market first" orientation, with provision to increase demand for recycled materials and to stimulate investment in recycling and reprocessing. The revised Act gave provision for tax credits for the purchase of recycling equipment, established a loans fund, provided for grants and research funding into recycling, funded market development studies, and encouraged government to have a paper procurement policy (Vincent 1988a:16). Features of the revised Act include a tripling of solid waste disposal fees and an obligation to reject developments that did not incorporate district recycling goals into their plans (Vincent 1988a:16). Such additions to the Act have provided an excellent orientation for the legislation to move towards, and incentive to encourage markets to be created for recycled and reprocessed products.

In some countries, recycling legislation may have faults, but if it is undertaken carefully in order to establish the optimum rate of recycling, and this level of recycling is higher than the rate of recycling which can be attained without legislation, then such measures may have an important role in appreciating the energy and resources which went into the initial manufacture of paper. If an optimal level of recycling and reprocessing is achievable by implementing budgetary options (such as expressed in 4.1-4.6), then industry should be given the opportunity to prove that they can achieve this level without the implementation of legislation.

CONCLUSION

The recycling and reprocessing rate of newspaper in Australia is currently relatively low. Justification for managing newspaper waste has been given on the grounds that it can reduce the pressures on native forests, reduce energy consumption, water use, the Greenhouse Effect and the disposal of newspaper in landfill. The primary emphasis of managing newspaper waste is to avoid its consumption. If newspaper cannot be conserved or re-used, it can be recycled or reprocessed. Reprocessing can be an appropriate mechanism for dealing with waste newspaper, particularly in areas where contribution to recycling schemes is difficult.

Newspaper can be used as a material for the manufacture many items, such as egg cartons, insulation, bricks, wall board, animal bedding, file folders, and fuel logs. It was found that the production of non-adhesive bonded wallboard and industrial fuel from newspaper are economically viable uses for newspaper in Tasmania in 1991.

The establishment of reprocessing industries has an important role in stabilising collection industries. To date, there has been an unfortunate precedent of newspaper collection industries failing to consistently demand newspaper, due to their inability to be independent of the fluctuating export market and cardboard manufacturers. This has led to a lack of confidence on behalf of the contributors to newspaper collection schemes. The establishment of reprocessing industries may induce stability in collection schemes by consistently demanding collected newspaper, and purchasing this newspaper for a relatively stable, elevated price. Ensuring that there are markets for reprocessed items has an important role in ensuring success of reprocessing industries.

Avenues for governmental, industry and community input into developing collection, recycling and reprocessing industries should be investigated. Incentives such as disposal levies, landfill charges, tax incentives, cheap loan repayments should be given to these industries, but only after a strict definition of such industries has been established. Research and development into recycling and reprocessing should be financially encouraged by industry. Community participation in collection should also be encouraged. Existing recycling and reprocessing industries should be supported via legislative mechanisms and by changing community attitudes towards recycled or reprocessed items. Legislation to enforce an elevated level of recycling or reprocessing should be encouraged only after the optimum level of recycling or reprocessing has been established by consulation with conservation groups and government bodies. If industry cannot achieve the optimum level of reprocessing or recycling on its own, the option of imposing legislation to elevate recycling and reprocessing should be considered.

The most environmentally sensitive and appropriate technological methods must be chosen when recycling or reprocessing newspaper. Reprocessing can be undertaken in close proximity to the source of collection, reducing pollution from vehicles and reducing transport costs. Low cost, low-scale technologies are often appropriate: this may reduce the requirement for large capital overheads. It is important to consider whether the interests of the community and the environment are best served by an increase in recycling or reprocessing: such activities should not be undertaken simply for their own sake.

The societal and environmental advantages of acheiving an optimal level of recycling or reprocessing, juxtaposed with the disadvantages of traditional forms of waste disposal, has resulted in the challenge to find low cost, environmentally benign recycling and reprocessing techniques. "The choice is ours: wastepaper...can remain a critical national issue or (it) can become among our country's most valued resources" (Setterholm 1991:79).

GLOSSARY

ABS: Australian Bureau of Statistics
ANM: Australian Newsprint Mills
ANZ Bank: Australia and New Zealand Banking Group Limited
APT: Appropriate Paper-based Technology
CSR: Commonwealth Sugar Refineries
CTMP: Chemo-Thermo Mechanical Pulping
Hammermilling: a form of mechanical milling of paper into very small particles
HEC: Hydro-Electric Commission of Tasmania
kcal: kilocalories
kWh: kilowatt hours
Landfill: the disposal of waste by burying in the earth or in disused quarries
NIMBY Syndrome: Not In My Backyard Syndrome
OECD: Organisation for Economic Co-operation and Development
ONP: old newspaper
Participation rate: amount of people contributing to the collection of recyclables, expressed as a percentage of the total number of people that could become involved in the collection scheme in the community
PNEB: Publishers National Environment Bureau
psi: pounds per square inch
RACT: Royal Automobile Club of Tasmania
RDF: Refuse-Derived Fuel
Recovery rate: the proportion of recyclable paper collected, expressed as a percentage of the total consumption of paper and paperboard
TRALAC: Tasmanian Recycling and Litter Awareness Council
Utilisation rate: the amount of recovered fibre used in the manufacture of paper, expressed as a percentage of the total fibre used.
WARMER: World Action for Recycling Materials and Energy from Rubbish

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Appendix 1

THE TOXICITY OF NEWSPAPER INKS

Traditionally, inks were known to contain cadmium, lead and chromium, but environmental and occupational health issues relating to inks are becoming pertinent (Goldberg 1991:54). The presence of these heavy metals in newspaper gave rise to concern that skin contact, consumption of newspaper via direct ingestion or by eating plant material treated with newspaper could lead to detrimental health effects.

Due to the confidentiality which often exists over the disclosure of the ingredients of inks, it is difficult to isolate whether toxins exist in newspaper inks. As some inks are made specifically for small markets, it may be difficult to make assumptions about the toxicity of all inks without chemical testing of each ink.

Australian publishers have been moving in similar directions to those in the United States, who have voluntarily removed heavy metals from inks; testing of a sample of printing inks at Cornell University in the United States has confirmed that virtually all inks contained purely an organic base (Goldberg 1991:54). There have been various assertions from ink manufacturers and the Australian newspaper industry that the inks used in newspapers are 'safe'. These assertions may stem from the fact that lead-based inks have not been used in Australia since the 1970's (PNEB 1991a:5). F.T. Wimble, suppliers of half of the market for Australian inks have indicated that their inks are essentially made from carbon black and bitumen, and that "virtually no heavy metals are now used in either black or coloured inks" (Industry Commission 1990b:70). There has also been a move towards the use of up to 100% soybean based inks by twenty-two newspaper publishers in Australia. The ink supplied to 'The Mercury' newspaper in Tasmania is essentially comprised of hydrocarbons, mineral oils and bitumen, and as such is not detrimental to health (D. Batten, Tasman Inks, pers. comm.). "Black ink is safe. You would need to drink three coffee cups of it to have a toxic reaction, or eat 375 pages of newspaper in one sitting"!(Queensland Newspapers Educational Services:4).

The issue of the toxicity of colour inks has also been reviewed. No heavy metals are added to process colour inks in Australia (Tony Wilkins, Environmental Secretariat, News Limited, pers. comm.). Background levels of heavy metals in process colour inks were present in parts per million, which is many times less than the Australian Standard for colours used in children's toys and colour comics. Blue spot colours, which are also used in Australia, contain copper, but this copper is tightly bound to a complex molecule, and copper is not dissociated from this molecule freely. The Food and Drug Administration of the U.S. find that newspapers with spot colours are acceptable to use to package food (Tony Wilkins, Environmental Secretariat, News Limited, pers. comm.).

It may be possible to assume that newspaper inks are suitable for use in horticultural or agricultural purposes, but, at the same time it is advisable to reduce exposure to these inks. If any application of uses for waste newsprint are to be implemented, it is recommended to err on the side of safety by either using newspaper which is printed with vegetable-based inks, or de-inked newspaper. Alternately, it is recommended that the ink is chemically analysed for toxins, which may be difficult if there is no indication from the supplier of what the ink can be analysed for, or no ink is supplied due to te requirement for confidentiality of ingredients. To de-ink, newspaper needs to be collected and processed, requiring economic, social and environmental costs. Newspapers which have been printed with vegetable-based or biodegradeable inks would be more suitable for reprocessing than newspapers printed with conventional inks

Other advantages of using vegetable oil-based inks can be presented. Worldwide concern about our rapidly depleting petroleum resources has given rise to the growing popularity of soybean based inks. Soybean oil is a renewable resource whereas petroleum is non-renewable (Anon 1990c:19). To soya bean farmers, using this vegetable oil-based ink could provide a boost to their farm production. Soy-based inks have low-rub qualities, reduced dot gain, enhanced colour reproduction and other technical advantages (Anon 1990c:19). The ink compounds of soy-based inks are easier to de-ink because they have large particles (Piers Petitt, Research Laboratories, ANM Boyer, Tasmania, pers. comm.). Also, vegetable-based inks do not contain the volatile organic compounds which are present in conventional inks, indicating that there may be greater safety in the workplace for newspaper printers. One problem with encouraging the use of vegetable-based inks is that printing machinery may need to be adapted.

There is potential for more publishers to use non-petroleum-based inks in Australia. The price of soy ink in Australia is higher than that of conventional inks because there are no commercal crops of soybeans in Australia, but these crops could be developed (Anon 1990c:19). Although the price of soybean based inks is dropping by 25% in the U.S., the price of standard ink is cheaper because of the pricing difference between soy oil and petroleum. It could be foreseen that if the price of petroleum increases, soy based inks could become more popular.

It was suggested that it was more likely for there to be toxins in newspaper than in newspaper inks (Nick Collins, Research Laboratories, ANM Boyer, Tasmania, pers. comm.). The possibility of having newspaper tested for the presence of toxic substances such as dioxins was dismissed due to the inadequacy of the technology required to test for the perceived minute amounts of dioxins in Australia (Noel Davies, Chemistry Department, University of Tasmania, pers. comm.).

Appendix 2

THE COST OF LABOUR IN 1991

There is no Trades Award specified for an employee of a reprocessing industry. It has been assumed that the Wholesale Trades Award is suitable for an employee of a reprocessing industry: this award has five categories of employee, ranging from a Level 1 employee, with less than 3 months experience, to a level 5 employee, who can guide and direct other employees. Each employer of a full time employee is obliged to pay this employee sick pay, holiday pay and four weeks annual leave loading (at seventeen and a half percent of the four weeks pay). They are also obliged to pay 3% of the wage in superannuation provision and 4% in workers compensation provision. Every employee is entitled to thirteen weeks pay after working for fifteen years: this means that 0.867% of one week's pay per year should be allocated to long service leave provision (Robert Millhouse, Department of Employment, Industrial Relations and Training, pers. comm.).

It was assumed, for the purpose of calculations, that either a level 2 employee, with more than three months experience, was to be employed, or a level 5 employee. The full-time wage of a level 2 employee is $337.80 per week, or $10.67 per hour on casual rates. If employed on a full-time basis, the total cost of employing a level 2 worker would be $19324.52. The cost of employing a full-time level 5 employee is $20832.35.